ENGINEERING NEWS-RECORD

A Consolidation of Engineering News, Engineering Record, The Sanitary Engineer, and The Contractor

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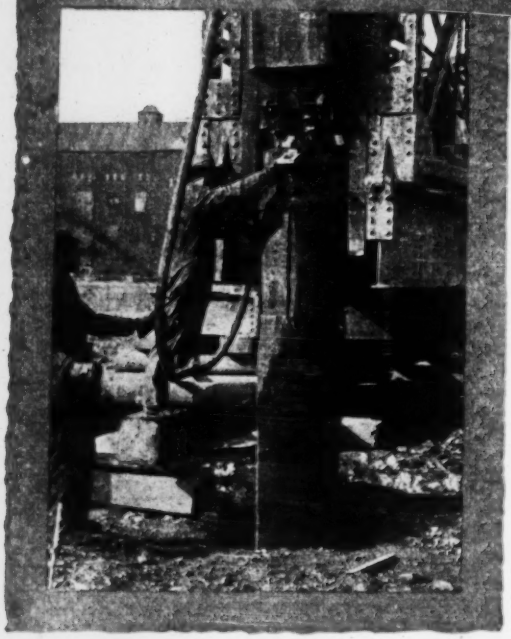

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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

F. E. SCHMITT, *Editor*

Volume 103 NEW YORK, OCTOBER 31, 1929 Number 18

Japanese Engineering

WITH the World Engineering Congress assembled in Tokyo it is natural that American engineers not fortunate enough to have gone to Japan for that great gathering should turn their thoughts toward the work of their fellow engineers in Japan. A fine example of what they are doing is presented in this issue in an article describing a hydro-electric development in Chosen. In conception, in magnitude of the undertaking and in the ingenuity displayed in meeting the construction problems encountered that project stands upon a par with the great hydro-electric power projects in this country and in Europe. In such details of this plant in Chosen as the surge chamber cut out of solid rock and the traveler over the penstock lines readers will find examples of the high grade of engineering that will be seen by those attending the Engineering Congress.

An Impressive Reminder

TIMELY discovery of dangerous foundation conditions at the San Gabriel dam site is a momentous event. Not only does it add another sensational chapter to the history of a project that has been marked by sensation throughout but it is a most impressive reminder of the risks inherent in every dam project—not to say every large engineering enterprise. The San Gabriel site had been examined by geologists and pronounced good, but geological forecast is not an exact science and may err in its prediction of the course and condition of rock strata under the surface. Borings and test-pits also are not as competent to detect bad foundations as is the construction excavation itself. The report of the consulting board on the present San Gabriel foundation conditions does not comment on the failure to discover earlier the serious faulting and crushing of the rock, but it gives the impression that the extensive fault zone at the toe and the sharply defined fault near the heel could not have been known or appraised in advance. Be that as it may, the conclusion that a dam of unprecedented height requires a thoroughly secure foundation is beyond contradiction. Indeed, the same condition should be imposed even upon smaller dams, for the menace of any dam is out of proportion to its size and nothing less can be tolerated than a security that will continue indefinitely. Ingenious theorizing on degree of safety, or estimation of the seriousness of this much or that much settlement or distortion, may be permissible for buildings, walls or piers; but a dam must have permanent and unchanging support beyond disturbance or deterioration.

Roadbuilders and Airports

VALUABLE information for the airport engineer and user was recorded at the municipal airport conference sponsored by the City Officials Division of the American Road Builders Association in Washington last week. At the same time, the important part that the roadbuilder can play in airport development, by virtue of his special training, was clearly demonstrated. Two papers stand out as distinctive contributions to the advancement of the art of airport construction. One of these reviewed the whole list of types of highway surfaces and analyzed their possible adequacy for airport use. The other was a remarkably useful discussion of drainage system design based on preliminary soil surveys and utilizing a recent grouping of soil types developed by the U. S. Bureau of Public Roads and Dr. Charles Terzaghi. Important as former airport conferences have been in impressing upon an ever-widening circle of Americans the value and necessity of ground facilities for air transportation, they have not been very productive of really usable information for the civil engineer and contractor charged with airport construction. The papers presented at them have been too general to be tangible. What has been needed is an examination of the various and multitudinous resources of civil engineering in the light of airport requirements. The roadbuilders' airport conference, through its two outstanding papers, has made an auspicious start in this direction. The advantage thus gained should be followed up without delay by sponsoring and even carrying out tests and experiments that will show how well the results of highway experience as outlined in these papers applies to airports. Any report which the City Officials Division may make to the parent organization at Atlantic City in January will be immensely enriched by the inclusion of such test data.

Pheasant Hunting

"HUNTING will be arranged for. The pheasant season will be open." In addition to a perfectly good program, thus runs the appeal to the red-blooded water-works fraternity of the West and Middle West to attend the fall meeting of the Missouri Valley section of the American Water Works Association at Sioux Falls, S. D. The program outlined is above the average in breadth and scope. It ranges from official welcome through highly desirable technical papers to enlightening bread-and-butter round-table discussions of such subjects as rates, collection methods, meter troubles and cold-weather precautions. Also there is provided the general run of inspection trips to points of interest in Sioux Falls, and golf—but the big urge, the real treat, the thing that appeals at once to the imagination and innate pioneer spirit with which every engineer is fundamentally, almost cogenitally, endowed, is the call to the hunt. He can see the frozen rigidity of the faithful pointer, he can hear the whir of the flushed covey and finally can exault in his own marksmanship. As an antidote to the mental fatigue of listening to papers on B. Coli determination, on oil engine pumping, on filtration plant operation, on iron removal, on chlorine application, will be the exhilaration of the hunting party. So long as water-works operators and technicians and their more commercially minded

friends making up the water-works industry as a whole give vent to their feelings pent up by restrictions of civilization in such he-man sports as the hunt, just so long will the hived-up city dweller continue to drink water that is safely and carefully collected, treated and purveyed. As an attendance inducement the pheasant hunt lure has no equal. Congratulations to the program makers. They have grass-root instincts.

New Achievement

NEW tasks and prospective new achievements in suspension bridge construction come into view with the start of cable stringing this week on the great 3,500-ft. span over the Hudson River at New York. In its elements the work is old and well known, for the essential steps in building parallel-wire cables are the same that have been practiced for more than eighty years; the method created by the first Roebling was complete and has survived through all this time. But in the Hudson River structure both dimension and volume attain such prodigious values as to set a problem which is fundamentally new. The greatest span so far built is 1,850 ft., while the present one is nearly twice as great: two cables 30¾ inches in diameter are the largest up to date, but now four cables of 36-inch diameter must be built. And, due to time demands, the entire cable work must be completed in little more than a year, in which time more than fifty million pounds of wire must be drawn across the river thread by thread and adjusted for perfect co-operation. Hence complete restudy of equipment and field methods by the contractors; hence also the radical innovations in mechanism and detail procedure which characterize the wire stringing across the Hudson at Fort Lee. The work promises to set a new model, a historic precedent, in the building of large suspension bridges. In the sober round of engineering tasks it stands out in dramatic contrast, and it may therefore be hoped that frequent reports of progress will be made public to record its steady advance toward completion.

A Remarkable Record

IT MAY truthfully be said that civil engineering often thrives on adversity. Certainly, many of its richest and most valuable experiences have been born of disaster. Such thoughts result from a contemplation of the truly remarkable progress made in completing the Mount Hope and Detroit suspension bridges, after the failures of the cable wires last April caused a virtual rebuilding of the structures. Dismantling work was begun on both about May 1. The Mount Hope bridge was opened to traffic on Oct. 24. Present plans report the official opening of the Detroit bridge, now the longest suspension span in the world, for Nov. 11. What have we learned from the unfortunate situation brought about by the cable failures? First, of course, we shall have the results of the several investigations which have already been made on the heat-treated cable wire, and of the coming study of an unusually large group of specimens from the Mount Hope cables which will be undertaken by the Bureau of Standards in Washington, all engineering records of great value. But beyond the purely technical aspects we have learned something about the great reserve power and ability of a construction organization by witnessing the almost unbelievable progress that such an organization can make when keyed up to a job and directed with courage and vision. To the field forces, the men on the firing line, goes the principal credit for this accomplishment. They have completed a job of which the whole profession should feel proud. Again civil engineering has been equal to an emergency, and again it has profited from failure.

Handwriting on the Wall

HOW far and how fast it is wise for holding companies to go in the increase of water rates is one of several questions raised by the vote at Davenport, Iowa, Oct. 12, on municipal purchase of the water-works recently acquired by one of the holding water companies. Rightly or wrongly, the impression is abroad that purchase by holding companies is followed as speedily as may be by rate increases.

The case is all the more interesting since the vote was close, and because Davenport seems to be the first large city to place before its electorate the question of municipal purchase of a water plant recently acquired in what may be described as the new era of holding companies. Interest is further heightened by the fact that although the Davenport majority against purchase was only 303, when a similar question was up in 1913 the majority against purchase was overwhelmingly large.

The change in public sentiment in sixteen years is so pronounced as to be significant. A more vigorous and more intelligently directed campaign for purchase might have turned the small majority against into a convincing majority in favor of purchase. To name only one argument against purchase that does not seem to have been well answered: It was alleged that municipal ownership would increase the tax rate. In a well-conducted campaign it should have been driven home that with a proper water rate schedule, water consumers, not taxpayers, would pay all capital charges and operating costs of the water-works, except those pertaining to fire protection, for which taxes are already levied to pay hydrant rental to the water company.

The smallness of the total vote at Davenport, only a fifth of the registration, suggests that municipal ownership was not a very live question in that city. Perhaps a gentlemen's agreement that no increase in rates would be requested by the company for five years, combined with the fact that this did not preclude a move by city and consumers for lower rates, had something to do with the light vote. Already there has been talk of an attempt to get the rates lowered, on the ground that profits under the new rates are excessive. This, combined with echoes in the editorial columns of the local press of sentiment against sending profits to Eastern capitalists, indicates that the slight majority against purchase has not settled the controversy over rates and friction with consumers that were mentioned as reasons for holding the recent purchase election. Intimation has been made of another election on the subject before long.

We have given brief space to the Davenport case because of its wide general bearing upon the further progress of the strong trend toward municipal ownership of water-works. There have been some attempts to foster the idea that holding companies are stemming the tide of municipal ownership that has been running so strongly for many decades. Some speakers and writers have gone so far as to say that the holding companies are buying municipally owned plants; but they have given neither place nor date of such acquisitions.

By and large the Davenport case seems not so much as a stemming of the tide against municipal ownership

as an example of the handwriting on the wall which may well be noted by water companies in general. It seems to have special significance for holding water companies —which in general, we are glad to be able to say, seem to be run with a large measure of regard for the public interest and with a view of obtaining the good will of their consumers. This must continue and increase if private ownership of water-works is not to become as rare in all of our states as it is already in many of them.

A Rational Waterways Policy

PRESIDENT HOOVER has restated his views on the development of the inland waterways of this country. He favors modernization of every part of our waterway system that will show economic justification, and insists that the construction of these new waterways be prosecuted on the same basis that any other transportation system would be built—"by extending its ramifications solidly outward from the main trunk lines." Moreover, he believes that the government should turn over the operation of barge lines to private interests as soon as they have passed the pioneering stage.

This is sound doctrine. If it can be followed, waterway development will be lifted out of the patchwork stage in which, as the President says, hundreds of millions of dollars of public money has been sunk in the past in disconnected local improvements, and will be put upon a business basis. Carried to its logical conclusion, the President's proposal demands a thorough study of the traffic possibilities of each waterway. It is perfectly feasible to determine with remarkable accuracy the productive possibilities and consumptive needs of each region reached by any one of the proposed waterways by a study of the amount and character, the origin and destination, of its exports and imports. When this has been done, it should be equally feasible to estimate what portion of the traffic can be moved by water and what portion must of necessity move by land. A fair and reasonable estimate of the income from the potential water-borne freight must then be set over against the cost of maintaining and operating the waterway before any determination of its economic justification can be made.

The President's Louisville address seems to indicate that he sees 9,000 miles of waterways in the Mississippi Valley as having economical possibilities. Are there now available any traffic studies to support this view? The Ohio-lower Mississippi River system makes up 2,200 miles of this total; the 6- and 7-ft. channels of the upper Mississippi and some tributaries make 1,400 miles more. What of the remaining 5,400 miles? Does anyone know whether they should have 9-ft. or 6-ft. channels, or if they should be built; does anyone know whether they will ever carry any appreciable amount of freight? Are the present 6-ft. and 7-ft. channels too shallow for modern needs? Is the money spent on them wasted, or should more be spent to deepen them? All these are questions that should be answered before the stamp of economic justification may be put on any one of the numerous projects that must have been included in the President's total of 9,000 miles. A program of expansion such as the President visualizes must be developed.

Presumably this work will be carried out by the Corps of Engineers. The civil functions of the Corps have been reorganized recently to facilitate construction of the proposed waterways, and its officers are not unfamiliar with the problems involved in making such an economic study, as they have made less comprehensive ones upon the possibilities of waterways built under the patchwork policy of the past. Under the new policy of building a unified system a much more comprehensive study will be both warranted and necessary. It should have the breadth and completeness of the economic survey of the St. Lawrence ship canal recently made by the Institute of Economics of the Brookings Institution. Great pressure will, of course, be brought upon the officers of the Corps to get them to disregard the essential unity of the plan in order to report favorably upon this or that waterway. They will need all the support the administration can give them if their waterways program is to measure up to the standard set by the President in his Louisville address.

Courage in Concrete

IN THE light of American experience, the design and construction of the Elorn bridge in France—three concrete arches of 612-ft. span—can be characterized in no other way than courageous. Few of our concrete arch bridges have attained half that span; therefore it is difficult to make comparisons. Wholly new conceptions of concrete as a structural material are necessary to understand this remarkable structure. For instance, where we use a 650-lb. unit stress for 2,000-lb. concrete, this bridge was designed on the basis of 1,000 lb. per sq.in., using an 8,500-lb. concrete; where we think of 5,000-lb. concrete as near the upper limit of present practice, the French concrete is said to have tested 8,500 lb. quite regularly throughout the construction period; where we use a liberal quantity of steel reinforcement to take tensile stresses, the French designers considered it only as an aid against changes in the arch due to temperature. American practitioners have often smiled at the European who specified variable and diverse concrete strengths in the same structure, the general feeling being that the European was radically bending his practice to suit his theory as contrasted to the American plan of formulating theories to agree with actual test results. In the case of some European dams wherein a dozen or more strengths of concrete have been specified and used, the American attitude was tenable; on these structures it seemed possible that the European was merely deceiving himself and that the major volume of his concrete as actually placed and regardless of what was specified would be of fairly uniform strength. It is wholly different with this French bridge; either the concrete is as good as it is claimed or else the bridge is potentially unsafe and possibly unstable. So far all indications point to a structure that is as sound as it is bold.

The boldness of the structure extends also to its methods of construction. Utilizing a compressed-air caisson as a diving bell, maneuvering a wood arch center of 600-ft. span as if it were a boat, and handling construction materials on a 2,300-ft. electric cableway, all represent construction of an unusual character. The description of the Elorn bridge in this issue should be read by every engineer. Especially is it recommended to those who may have acquired the belief that, in view of our skyscrapers, our huge dam projects and our long suspension and steel arch bridges, we have gone far ahead of civil engineering in Europe. It is not only in finance and politics that we must develop an international mind. Civil engineering, too, demands a worldwide interchange of knowledge.

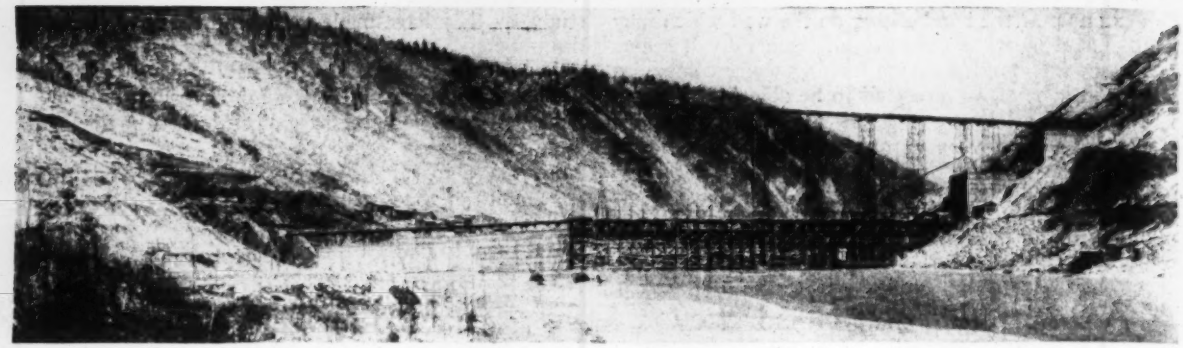


Fig. 1—Upstream View of the Dam During Construction

Largest Hydro-Electric Plant of the Orient Being Built in Chosen, Japan

260,000 Hp. to Be Developed in Three Steps—Total Effective Head 3,342 Ft.—Flow Only 825 Sec.-Ft.—Water to Be Diverted Through 16.65-Mile Tunnel From One Watershed to Another

By Taneyuki Matsumura

Chief of Erection Department,
Chosen Hydro-Electric Company, Chosen, Japan

Construction of the largest hydro-electric power plant in the Orient has been under way near the northern border of Chosen (formerly Korea) since 1926. The first stage of the work is now practically finished. When the two remaining stages have been completed the project will have installed in its three power plants units having a total capacity of 260,000 hp. The project is notable not only for its power possibilities but also for the long tunnel used to divert water from one watershed to another, the high head developed in the first plant, the high-pressure penstock line, and also the construction methods adopted.

—Editor.

THE largest hydro-electric plant in the Orient, in which 260,000 hp. will be developed, is being built in Chosen (Korea), Japan. The site of the plant is very favorable for the development of a large amount of power. The Fusenko River, a branch of the Oryokuku (Yao-lu) River, has its source in a range of mountains 5,000 to 6,000 ft. high and runs about 100 miles to join the Oryokuku. These mountains have a steep slope on their southern side toward the Japan Sea. The Fusenko River is being dammed at a gorge about 25 miles north of the ridge line of the mountains by a 250-ft. dam which will form a reservoir of about 25 billion cubic feet capacity. By conducting the stored water to the southern side of the ridge—that is, to the Japan Sea side—it will be possible to obtain, by three steps of conduits and power stations, 260,000 hp.

The three steps of waterway and power stations consist of the following:

	First Step	Second Step	Third Step
Length of waterway, miles	16.65	3.5	3.8
Effective head, ft.	2,335	693	314
Length of penstock, ft.	9,730	1,570	776
Gross weight of pipe, tons	12,000	1,200	850
Number of sets of waterwheels and generators	4	2	1
Developed horsepower	180,000	55,000	25,000

Most of the power developed will be utilized for the production of nitrogenous fertilizer and will be transmitted 38 miles by three double-circuit 100,000-volt tower lines. It is expected that 300,000 tons of fertilizer per year will be produced. In the summer of 1926 the first step in this power development was begun and construction on the second step is expected to begin late in the summer of 1929. What follows describes briefly the first step development only.

Dam and Reservoir—The dam is a concrete gravity section of the overflow type, 250 ft. high, 1,308 ft. long and 184.24 ft. wide at the base at the maximum section, excluding the apron. A cut-off trench 10 ft. deep and 10 ft. wide at the bottom was excavated at the heel of the dam, as is shown in Fig. 1. Two rows of grouting holes, 50 ft. deep and 20 ft. apart, for cement grouting, were bored, one row at the center of the cut-off trench, the other 10 ft. downstream. Both calix drills and drifters were used to drill the grout holes, but better results were obtained from the drifters. Using 1¼-in. round steel, the size of the drilling bit was 4 in. at the start, the size being gradually reduced to 1¾ in. at 50 ft. depth.

The bedrock at the dam site is granitic gneiss. To reach a firm stratum, all loose material, as well as 5 to 10 ft. of loose rock, was removed. In designing the dam section an uplift force was considered ranging from one-half the amount of static pressure at the heel of the dam to zero at the toe.

The concrete was mixed in the proportion 1:3:6, except at the base and at the lower part of the dam, where a 1:2:4 mix was adopted.

Because of the large amount of concrete used—640,000 cu.yd.—the construction of the dam was divided into two stages in order to develop electric power as quickly as possible. As the elevation of the top of the dam is 4,031 ft. and that of the intake is 3,928 ft., the elevation of the dam in the preliminary stage was fixed at 3,960 ft. The volume of concrete used in this stage is about 224,000 cu.yd. When the preliminary stage is

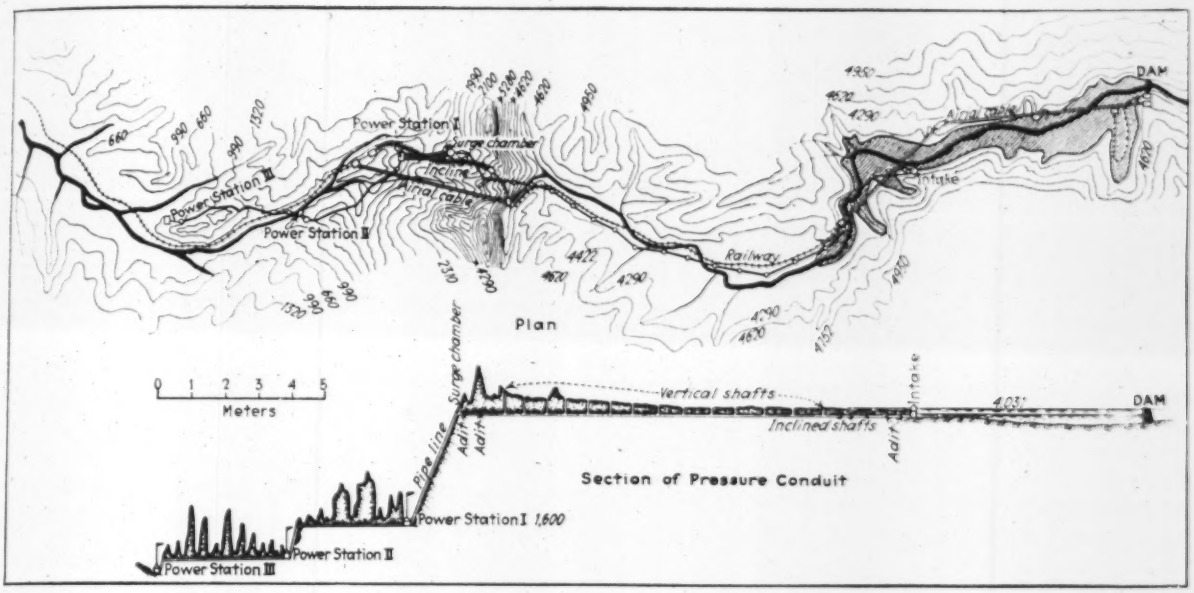


FIG. 2—PLAN AND PROFILE OF POWER PROJECT

completed, about 70,000 hp. may be developed. This output can be continued during the second stage of construction.

On completion of the dam the reservoir will have an area of 9.3 square miles and a capacity of 25 billion cubic feet. Ten years' observation of rainfall and runoff has led to the deduction that by utilizing 15 billion cubic feet of reservoir water, a constant flow of 825 sec.-ft. can be obtained throughout the year, which would develop a total of 260,000 hp.

Intake and Waterway—The waterway consists of a horseshoe-shaped, concrete-lined tunnel, 13 ft. 3 in. x 12 ft. 3 in. As the length of the tunnel in the first stage is 16.65 miles, it was divided into twenty sections by four adits, three inclined shafts and fourteen vertical shafts, in order to complete it in 30 months. To avoid an inflow of sand and mud into the waterway, the intake is situated about 20 ft. above the reservoir bed on the hillside. From that point the waterway tunnel, having a slope of 1 in 1,500, runs under the plateau and reaches the surge chamber at the south side of the ridge line.

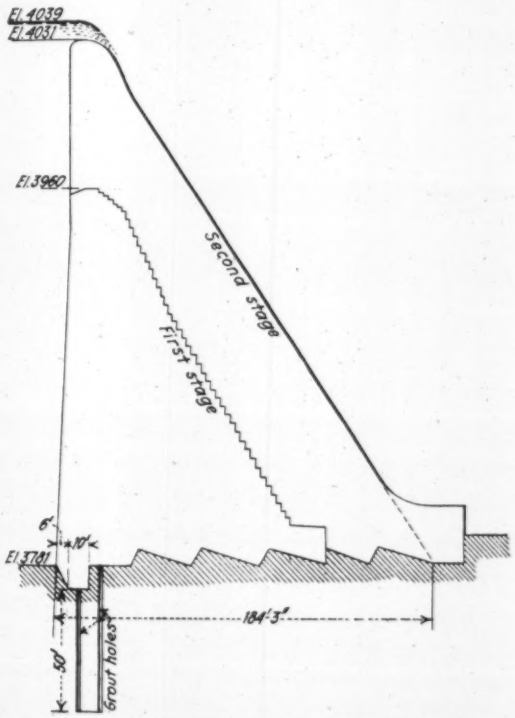


FIG. 3—MAXIMUM SECTION OF THE DAM

The intake consists of three steps of gates having eight gates in each step, which spreads on a circular sector, as shown in Fig. 10, in order to let in water from every gate to the waterway with as uniform velocity as possible. When the water in the reservoir is at its maximum height the gates in the uppermost step are left open, and as the water level falls the middle and the lower gates are successively opened. The operating handles of the intake gates are under water and cannot be operated unless the water reaches a certain level; therefore two gates, one caterpillar and one sluice, the sluice acting as an auxiliary, are placed in the waterway in a vertical shaft 100 ft. behind the intake gates. These will be operated in case it is necessary to empty the waterway.

Two of the adits previously mentioned are excavated in the hillside near the intake; below them are the three inclined shafts and fourteen vertical shafts. These shafts vary in depth from 120 to 535 ft deep, the deepest one being on the penstock side. The other two adits, each about 700 ft. long, are located at the south side of the ridge line near the penstock.

The total inflow of water to the shafts and tunnel is about 2,000 cu.ft. per minute, the largest amount from any one shaft being 250 cu.ft. per minute. Water is pumped from the shafts by pumps with a total horsepower of 3,000. Besides these pumps air compressors with a total horsepower of 1,900—seventeen of 100 hp. and four of 50 hp.—are used to operate the rock drills.

The rock through which the tunnel runs is mostly granitic gneiss in moderately firm condition. Since the waterway tunnel must bear a pressure head of 150 to 200 ft., special attention has been paid to the concrete lining. One part of the tunnel, on the south side of the ridge line, runs along the slope of the mountain for about 1½ miles and is covered with several hundred feet of rock all the way. As this portion of the tunnel might crack

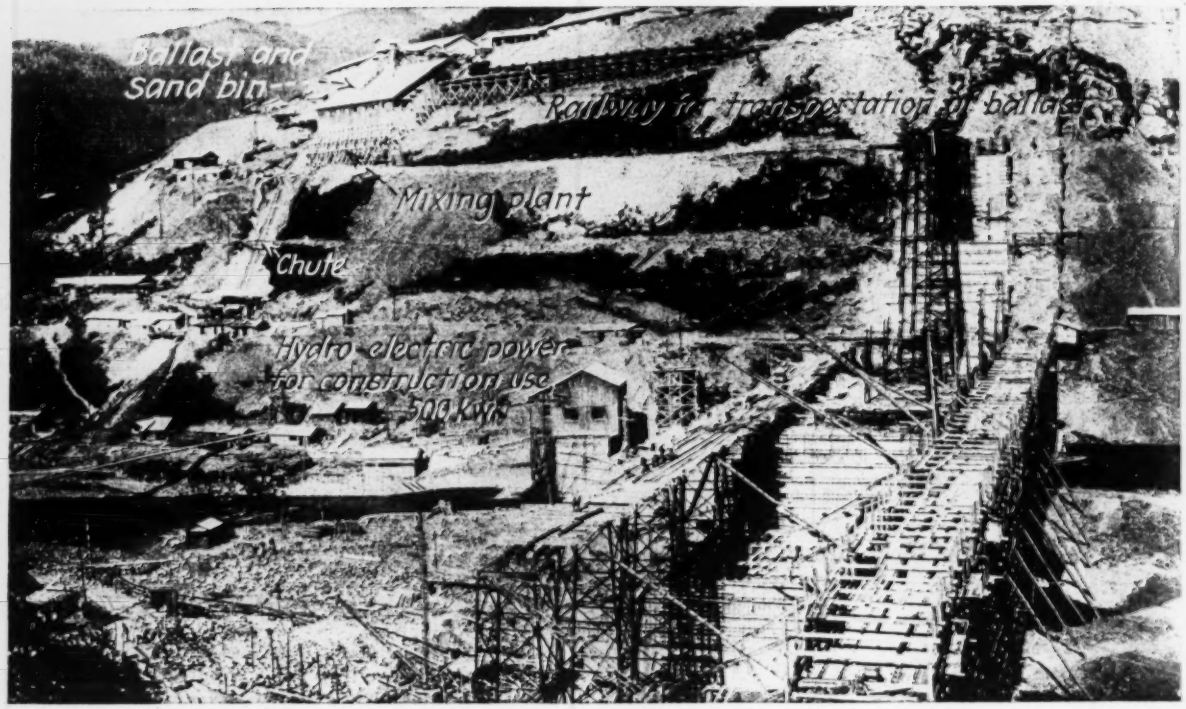


FIG. 4—CONSTRUCTION PLANT AT THE DAM

and discharge water, it has been reinforced with steel designed to withstand a tensile stress of 30,000 to 40,000 lb. per sq.in. Reinforcing steel is also used in other parts of the tunnel where the rock is weak or where there are faults in the stratum. After the lining is finished the space behind it throughout the length of the tunnel will be filled with grout mortar under a pressure of 70 lb. Thus with steel reinforcement and mortar grouting the tunnel can withstand a high pressure head.

Surge Chamber—At the end of the pressure tunnel there has been excavated a surge chamber to take up or to supply water during a change of load on the generators in order to reduce an excessive internal pressure or partial vacuum in the penstock. This surge chamber, shown in Fig. 6, is constructed as a vertical shaft of circular section with an inside diameter of 30 ft. at the bottom and of 15 ft. at the top. It is lined with concrete 14 to 18 in. thick, the lining being reinforced with steel about three-fourths of its depth from the bottom.

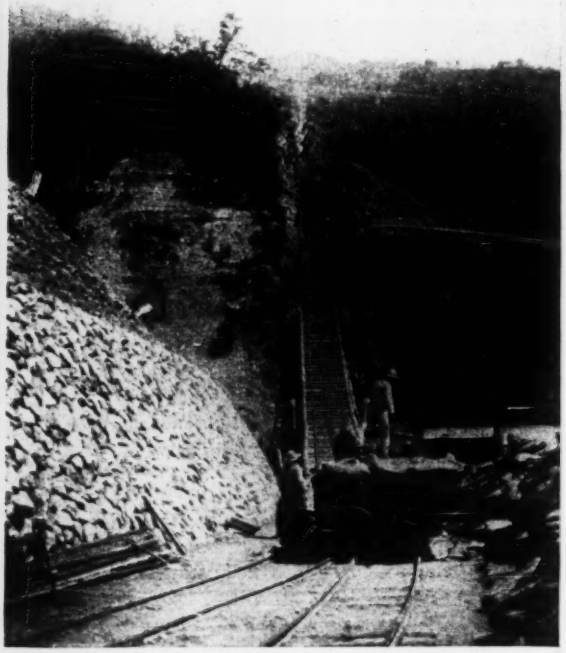


FIG. 5—PART OF THE INCLINE CABLEWAY

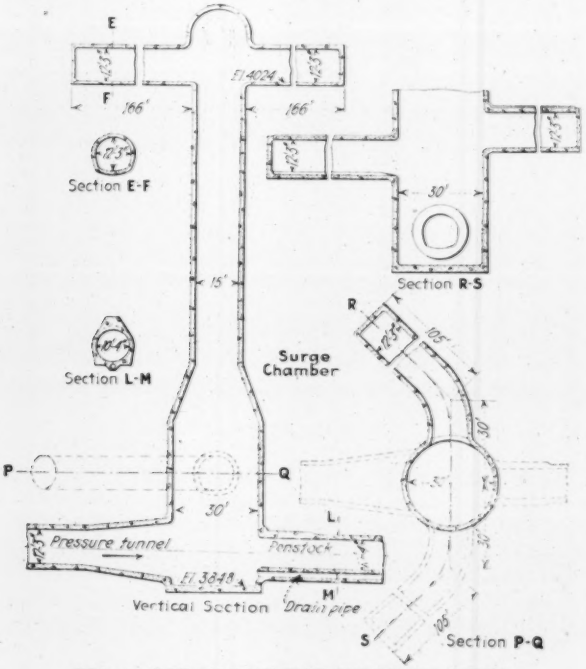


FIG. 6—DETAILS OF THE SURGE CHAMBER

FIG. 7—PENSTOCKS UNDER CONSTRUCTION

To increase the capacity of the surge chamber, four auxiliary horizontal chambers in tunnel form are provided. Two of these are at the top and two near the bottom of the main chamber, as shown in Fig. 6. The upper two auxiliary chambers serve as a part of the surge chamber during an instantaneous change of load on the generator when the surface of the water is comparatively high, and the lower two will supply water to the penstock during an instantaneous increase of load on the generator when the surface of the water is comparatively low.

Penstocks—From surge chamber to turbines the length of the penstock is 9,730 ft., of which the upper 550 ft. consists of pipe $\frac{7}{16}$ in. thick with an inside diameter of 10 ft. 4 in. It branches into four lines at a valve house, where two butterfly valves are fitted to each line, one of which may be operated by hand as well as by motor. The motor operation is performed by pushing a button on the switchboard; the other valve may be operated by a switchboard push button, but in case of emergency it acts automatically. Two air valves are attached to each pipe line in the valve house, one being auxiliary, to let air into or out of the pipe automatically. Because of the very high altitude the minimum temperature at the valve house site is —35 deg. C.; therefore it will be heated electrically during the cold season.

Since the surge chamber is constructed by excavating a vertical shaft 250 ft. deep, the upper part of the penstock has a certain depth of rock cover; therefore the 10 ft. 4 in. diameter pipe is erected in a tunnel 15 ft. in diameter. The space outside of the pipe is to be filled with concrete. From the valve house downward the penstock consists of four pipe lines, each with an inside diameter of 64 in. at the upper end and 45 in. near the waterwheel. Those at the upper end, under 950 ft. head, consist of riveted pipes with bump joints; those at the lower end are banded pipes with butt strap joints. The

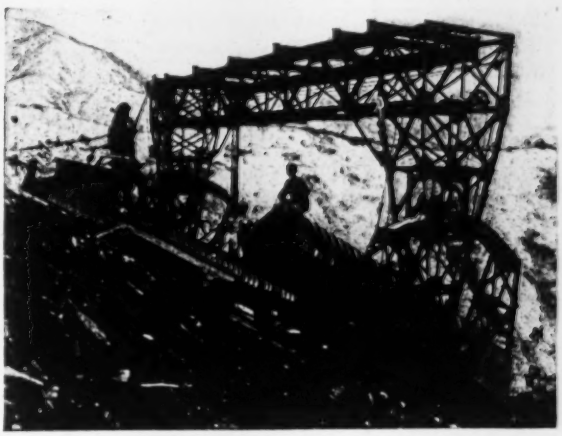


FIG. 9—TRAVELER FOR PENSTOCK ERECTION

pipe lines have twenty anchor blocks, which contain 20,160 cu.yd. of concrete.

In the placing of these pipes two erection cranes, newly designed, are used. These cranes stand over the pipe lines and can travel up and down by means of wire ropes attached to hoisting machines; moreover, the posts of the crane girders are built to stand vertically against any slope of the pipe line. Use of these cranes greatly reduced the time required for the erection of the pipe.

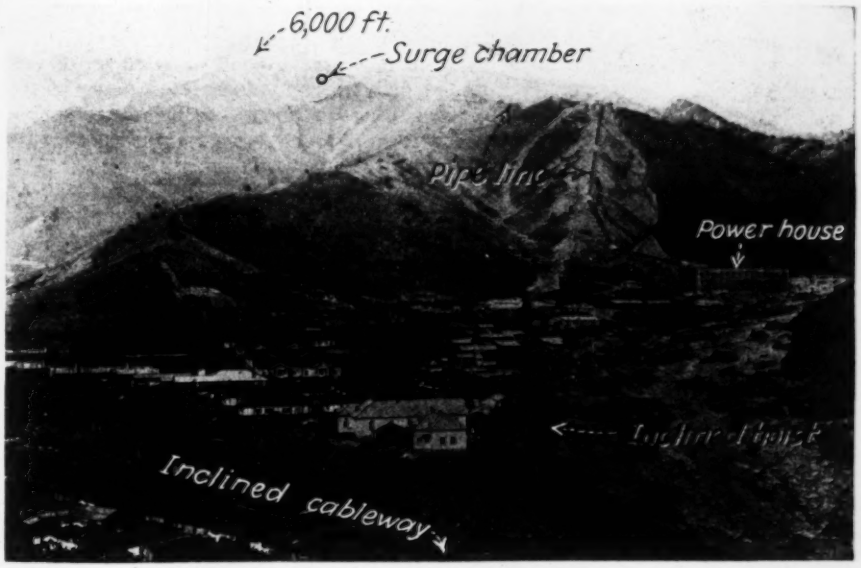


FIG. 8—POWER STATION NO. 1 AND PIPE LINE

Power Station—The power house is built of concrete. The building area is about 18,500 sq.ft. and the total floor area is about 23,000 sq.ft.—that is, 0.18 sq.ft. per kilowatt of the station output. The house consists of two sections, one of which is the generating room, in which four turbine-driven generating units are to be installed; the other section is for switchboards, field rheostats, 11-kv. oil circuit breakers, station service transformers and office. The generating room is 65 ft. high and is equipped with a 150-ton overhead traveling crane. All 110-kv. switch gears, lightning arresters and main step-up transformers are installed outside of the power house. In ground area this outdoor transformer and switching station covers a

space of about 29,000 sq.ft. The water turbines are of the double-nozzle, single-runner horizontal impulse type of three-bearing arrangement. They run at a speed of 360 revolutions per minute. The nozzle diameters are 7.32 in. The turbines are rated at 45,000 hp. and the generators at 36,000 kva. The latter are of the totally inclosed horizontal shaft type, 11,000-volt, 60-cycle, made by Siemens Schuckert Werke, of Germany.

Subsidiary Plants for Construction—Owing to the inconvenient location of the power plant, several subsidiary plants for construction had to be provided.

For transportation of machines and materials, a light railway of 2 ft. 6 in. gage, 13 miles long, has been built from the terminus of the existing railway to the power station; also in the upper plateau there has been laid 14 miles of railway of the same gage, which runs along the shafts of the waterway to deliver materials to the tunnel. Since there is a difference of level of about 3,000 ft. between the site of the power station and the upper plateau, these two railways are connected by an inclined cable hoist, of the three-rail fulcrum system, 4½ miles long. This incline ascends 3,600 ft. in 3½ miles, then descends 600 ft. to join the upper railway. The steepest slope in the incline is 34 deg.

In addition to the inclined hoist an aerial cableway 4.6 miles long connects the upper and the lower railway to transport materials to the waterway and dam plant from the lower site. The capacity of the cableway and inclined hoist is 100 tons each in ten hours. From the terminal of the upper railway to the dam site there is an aerial cable 10 miles long with a capacity of 150 tons in ten hours, which is used mainly for the transportation of cement and coal. At first it was intended to extend the railway to the dam site, but as it would have to pass over the bed of the reservoir and would be drowned by the dammed water during the construction of the dam, the aerial was decided upon.

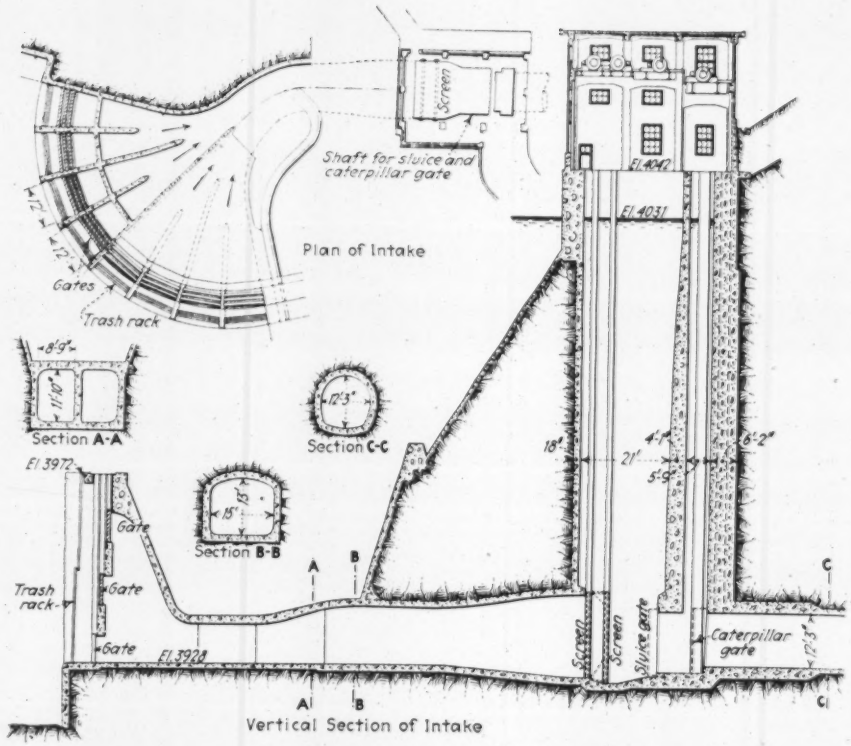


FIG. 10—DETAILS OF THE INTAKE

FIG. 11—UPPER SECTION OF THE PENSTOCK LINES UNDER CONSTRUCTION

At the dam 3 miles of double-track light railway was built for transportation of ballast and sand. Four steam shovels collect ballast and sand for concrete used in the construction of the dam, and these materials are also handled by hand laborers. About 1,600 cu.yd. of concrete is placed daily except during the winter season. Owing to the extraordinarily low temperature, a minimum of —40 deg. C., concreting is suspended from December to April.

Electric power equipment for construction use is installed as follows: six sets of 350-kw. diesel engines, a total of 2,100 kw.; one 800-kw. steam turbine, and one 800-kw. and one 500-kw. hydro-electric units. Thus a total of 4,200 kw. of power is applied to construction equipment, which includes air compressors, pumps, concrete mixers, hoisting machines, cableways and other apparatus.

The total cost of the project is estimated at $22,000,000 for the three steps of construction. The cost of the first step will be $17,000,000, which includes the cost of the dam and subsidiary equipment. The second and third steps do not involve as much construction, as the tunnels and pipe lines will be shorter and less head is to be developed in the power stations. This may be seen from the plan and profile shown in Fig. 2 and in the tabulation on p. 678.

Rebuilding Colorado River Bridge Pier After Collapse

Overturned Pier and Debris in the Two Submerged Spans Hinder Work—Deep Sheetpiling and Tremie Concrete Used

ON JUNE 14, 1928, the highway toll bridge across the Colorado River at Blythe, Calif., lost two of its five 190-ft. steel spans when the second pier from the western end was washed out by a flood (*Engineering News-Record*, June 21, 1928, p. 985). Since then the bridge has been rebuilt; it was opened to traffic March 5. Only one of the two fallen spans could be salvaged. This one and a new second span are supported on a new pier located on the old pier site. The new pier has the same depth of concrete as did the one that failed, but is protected by deeper sheetpiling and a brush-and-rock mattress.

The bridge had been in service about three months when the flood damage occurred. The pier that went out was founded on concrete carried 32 ft. below low-water level, at which depth the foundation was in a well-cemented layer of gravel containing large "niggerheads," the thickness of this layer of cemented material being about 22 ft. Steel sheetpiling 45 ft. long extending 42 ft. below low water inclosed the concrete.

Prior to the flood, irrigation interests cut across a bend in the river above the bridge, to straighten the main channel. The current through this new channel met the current in the original channel just above the bridge, and trees removed in cutting the new channel collected in a large mass against the destroyed pier, causing a hole about 150 ft. wide to scour through the layer of cemented gravel on which the pier was founded. Eye-witnesses report that when the flood was at its height the pier settled vertically 2 to 3 ft. and then for 40 minutes remained stationary, after which it tipped over, downstream, and disappeared. Subsequent operations led to the conclusion that the fallen pier lies in a nearly horizontal position.

Of the two fallen spans the one farthest from shore lay on its side almost entirely buried in sand and drift. It was found to be impracticable to raise it, and with the permission of the War Department the upper side,

IN SPAN NO. 1 BELOW WATER LEVEL
Débris has been removed and preparations are being made for jacking.

CLOSE VIEW OF DEBRIS ENTANGLING SPAN NO. 1
Excavation had to be completed by hand before the raising commenced.

which happened to be the upstream truss, was removed by using the oxyacetylene torch to cut transverse members at a level not less than 10 ft. below low-water line. Because of the sand bar that silted up around the span, it was possible to excavate around the members to cut and keep the excavation unwatered by pumps while the cutting was being done. The remainder of the span was left in the streambed.

Span No. 1 was lying in an upright position with the outer end lower than the shore end but with most of the steelwork below low-water level. The sediment deposited around this span contained so much drift and débris that it was only with the greatest difficulty that the span was freed from it. Practically all the excavation had to be done by hand. At the outer end of the span the work was done in a cofferdam.

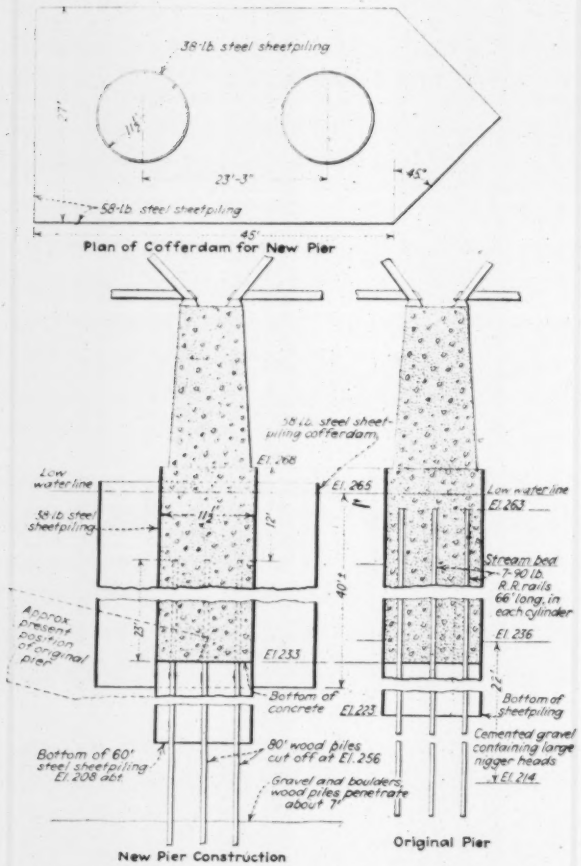
For raising the span when cleared piles were driven opposite each panel point and 16x16-in. caps were laid across the top of the span, extending from the piles on one side to those on the other. A 50-ton screwjack was placed under each end of these caps and cables were run down to the top chord. The jacking process was then begun. The jacks were run up to their full 1-ft. extension and then one by one blocks were changed under each jack for another 1-ft. lift. After each 3 ft. of lift, one by one the cables were changed to a new hold.

The span was 190 ft. long and weighed about 130 tons. This was distributed over twenty jacks, of which one pair was located at each of the ten panel points. As the top chord of the trusses rose to the level of the pile top, the caps were transferred to locations below the top chords and jacking continued until the span was at the desired level for replacement in the bridge with its bottom chord resting on top of the caps across the piles. The total lift represented a height of about 60 ft. at the east end and 40 ft. at the west end. After the raising of the span had been completed about 12 tons of steel was replaced, a considerable part of this being two end posts and the adjacent bottom chord member which had been entangled with a 24-in. log.

The reconstruction of the pier was a more complicated problem. Owing to the decision to reclaim the two fallen spans if possible, upon which point the insurance company insisted, it was necessary to construct the new pier on the site of the old. It was decided to construct the new pier substantially according to the original plans except for the use of longer steel sheetpiling and the use of timber piles in place of the 90-lb. rails used in the original construction.

The first step in such reconstruction was the driving of a cofferdam, of 58-lb. sheetpiling 40 ft. long, in a 27x45-ft. rectangle having a pointed nose on the upstream end and inclosing the area within which the original pier was built. This driving was exceedingly difficult due to drift embedded in the riverbed. Part of the sheetpiling brought up on the overturned cylinder bases of the old pier. This large cofferdam was pumped down and cleaned out to a depth of about 24 ft. At this point the capacity of the four centrifugal pumps, rated at 1,000 gal. per minute at 150-lb. pressure, was reached. It was impossible to stop the blow-ins along the cylinders of the old pier, as the drift and brush around the cofferdam prevented caving, which might have made possible the sinking of sandbags to seal between the sheetpiling and the old cylinders.

The plan of operation was consequently changed. The sheetpile (13¼ in. 38-lb., 60 ft. long) for the new 11½-ft. cylinder bases were then set up inside the large

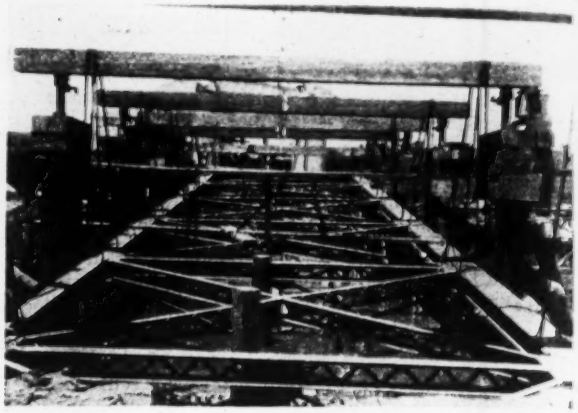


SKETCH SHOWING PLAN AND ELEVATION OF RECONSTRUCTED PIER (LEFT) AND FOUNDATION OF ORIGINAL PIER (RIGHT)

cofferdam and driven, although not without considerable difficulty. In that part of the work where the piles encountered parts of the old pier such obstructions were cleared by the use of a fishtail chisel on a long and heavy kelly bar, that could be placed under the pile hammer, and by a cross-shaped churn drill 30 in. in diameter.

In each cylinder 80-ft. timber piles were driven, ten in one and eleven in the other. The average penetration of these piles was 77 ft. below low water, giving about a 7-ft. penetration into a lower boulder bed as indicated by the driving and jetting. The jet used consisted of a 2-in. nozzle at the bottom of a 3-in. pipe, supplied by two fire hose, 2½ in. in diameter, connected to a Y at the top of the jet, under a pressure of 250 lb. All piles had metal shoes, part consisting of two 3x½-in. straps crossed over the trimmed tip of the pile and others made from 10-in. well casing, 5 ft. long, whose lower end had been cut with a torch and welded into a cone-shaped point.

Even with such jetting equipment, which was usually sufficient to float up the pile at any point of the driving above the lower boulder bed, it was extremely difficult to get the piles through the boulder bed in



ARRANGEMENTS OF JACKS AND CAPS FOR LIFTING
The cables were shifted to a new hold after each 3-ft. lift.

which the original cylinder bases were founded. Attempts to drive the timber piles without the jet resulted only in brooming the tips of the piles, thus necessitating pulling such piles and renewing the metal shoes. The piles were cut off 12 ft. below the top of the sheetpiling; thus there is 23 ft. of the timber piles in the concrete and 45 ft. below the bottom of the concrete.

The cylinders were pumped and cleaned out to a depth of 35 ft. below the top of sheetpiling, or 32 ft. below the elevation of low water. For such pumping half of the pumping equipment pumped from the large cofferdam and the remaining half from one of the cylinders. At the depth of 32 ft. below low water several blow-ins occurred and it was not possible to extend and maintain the pumping and excavation below that depth.

After cleaning out the cylinders the lower 15 ft. of concrete therein was placed through a tremie with the large cofferdam pumped down about 20 ft. The concrete was carried above water level in a dumb-bell section, the connecting web being put in as soon as concrete had been carried up to the top of the sheetpiling.

The final operation in the construction of the bridge was to protect all river piers with mattresses made up of two layers of wire mesh with brush and rock between. These mats were laid 80 ft. wide and 150 ft. in length, of which 80 ft. extended upstream from the pier and 70 ft. downstream.

The original bridge design was prepared for the California-Arizona Bridge Company, a San Francisco corporation, by Harrington, Howard & Ash, and S. B. Lane was resident engineer, on construction. The W. M. Ledbetter Construction Company was the contractor. The same organization directed the reconstruction of the pier.

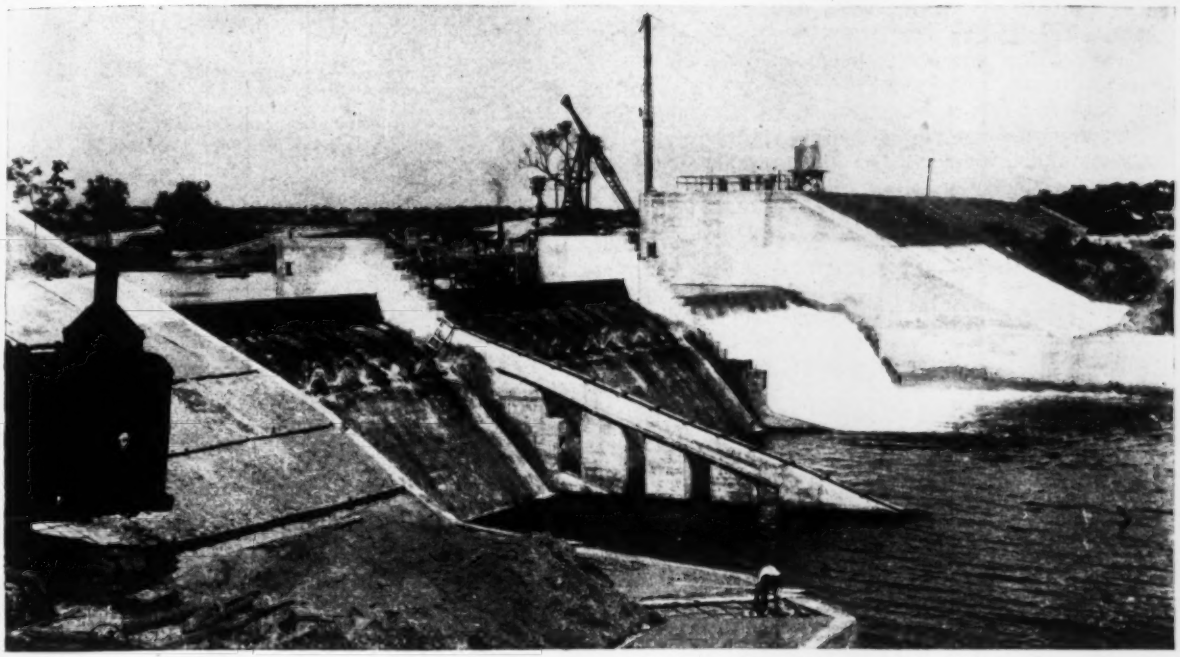


FIG. 1—POWER DAM ON GUADALUPE RIVER, TEXAS
The dam was nearly completed when this picture was taken, October, 1927. The reservoir was partly filled and the gates in the two nearer bays are at part height. The far gate is in lowered position.

Automatic Roof Weirs Used for Reservoir Control on Guadalupe River

Crest Gates Similar to Bear-Trap Floodgates Used at Three Power Plants in Southern Texas—Largest Gates Yet Built to Design That Was Developed in Europe

By E. L. Chandler
Price Brothers Company, Dayton, Ohio

WITHIN the past year the Texas Power Corporation has completed three hydro-electric developments on the Guadalupe River, approximately 40 miles east of San Antonio, Tex. The largest of the three developments is located about 6 miles downstream from the city of New Braunfels. It consists of a dam with a reinforced-concrete spillway section, and a canal which is equipped with a head-gate structure at its upper end and leads to the power house about 8,800 ft. downstream on the left bank of the river. This project develops a total head of 46 ft.

The second development is located at McQueeney. Here the power house is combined with the concrete spillway, developing a head of 31.5 ft. The third development is about 5 miles below Seguin. It is similar in design to the first, consisting of a dam and a power house connected by a canal. The head developed is 26.5 ft.

Generating equipment is similar at all three power houses. Each installation consists of two units composed of a turbine direct connected to an electric generator, the capacities per unit being respectively 1,800 kw., 1,400 kw. and 1,240 kw., a total maximum capacity of 8,880 kw. The system is designed for remote control of the upstream and downstream installations from a main switchboard at the McQueeney power house.

Some interesting features of design are found in the spillway structures, particularly in the type of automatic floodgates used. Dimensions of the gates are identical at the different dams and the upstream one will be described as being typical.

The concrete spillway at this dam is located in the old streambed, earth embankments extending from the abutments to the hills on each side of the valley. The spillway proper consists of three bays, each 85 ft. wide between piers. Fig. 1 is a view of the downstream face of the structure. The downstream extension on the nearer intermediate pier is a fish ladder. Embodied in the distant abutment there is the mechanism for operating the automatic roof weirs, and it is, therefore, known as the operating pier. Further description will be given later. Fig. 2 is a section through the middle bay of the spillway, showing sufficient details to give an understanding of the dimensions of the dam. The general scheme of construction will be evident from a study of Figs. 1 and 2.

Automatic Roof Weirs—Each floodgate, or automatic roof weir, as they are called, consists of two leaves, as may be seen in the several illustrations. The downstream leaf is built with a framework of thirteen steel trusses parallel to the direction of streamflow. Trusses are spaced 6 ft. 8 in. on centers and each one is fastened to

a post in the downstream concrete sill by means of a heavy hinge pin connection. The whole structure is tied laterally with a system of secondary trusses. Details of the construction are shown in Fig. 3, in which one of the downstream leaves is being assembled. The hinges may be seen on the right in this view. The upstream leaf consists of the same number of trusses, although they are quite different in design. In this case each truss is hinged to a post in the upstream concrete sill and terminates at its downstream end in a heavy cast roller resting on top of a corresponding truss in the downstream leaf. (See Fig. 4.)

All trusses are built with flanged recesses along the top members, whose function is to hold in place timber members which form the deck of the gates. Deck thickness varies from $2\frac{3}{4}$ to $5\frac{1}{2}$ in. in different portions of the structure. The timbers are of creosoted pine, grooved for splines, and each one is carefully fitted for its proper position. In Fig. 4 the downstream deck has been partly placed, and some of the timbers are to be seen lying about.

In the process of assembly the first step is the placing of the trusses for the downstream leaf in approximate

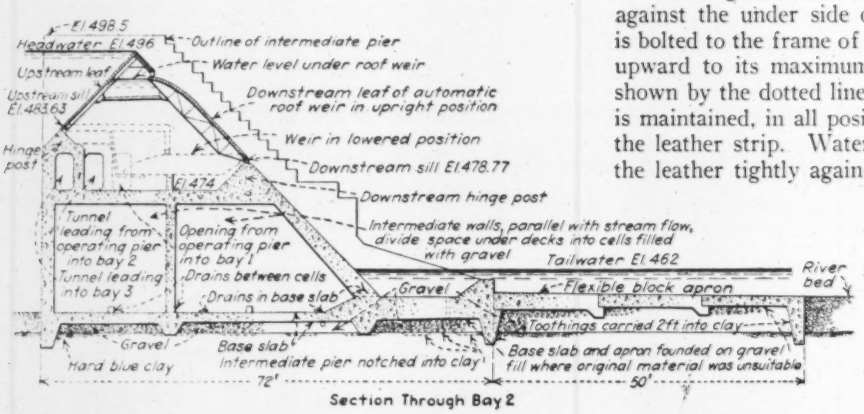

El 498.5
Headwater El 496
Outline of intermediate pier
Water level under roof weir
Upstream leaf
Upstream sill El 483.63
Downstream leaf of automatic roof weir in upright position
Weir in lowered position
Hinge post
Downstream sill El 478.77
El 474
Downstream hinge post
Intermediate walls, parallel with stream flow, divide space under decks into cells filled with gravel
Tailwater El 462
River bed
Tunnel leading from operating pier into bay 2
Tunnel leading into bay 3
Opening from operating pier into bay 1
Drains between cells
Drains in base slab
Gravel
Flexible block apron
Toothings carried 2ft into clay
Gravel
Hard blue clay
Base slab
Intermediate pier notched into clay
Base slab and apron founded on gravel fill where original material was unsuitable
72'
50'
Section Through Bay 2

FIG. 2—SECTION THROUGH THE CENTRAL BAY OF THE DAM

position with the hinge posts hanging loosely in recesses left in the downstream sill to receive them. The lateral system is next bolted in place. The whole steel framework is then brought into a true alignment, the hinge pins are set accurately to position and the hinge posts grouted in place. Following this the framework is riveted. Timbers for the deck are then slipped into place and wedged tightly up against the top flanges of the trusses by means of hardwood wedges inserted between the under side of the deck and the lower flanges of the recesses in the steel members. A similar procedure is followed with the upstream leaf.

The roof weir depends for its action on carefully regulated hydraulic pressure acting on the under side of the deck; therefore it is necessary that there be a tight sealing of the leaves against the concrete piers and sills and at the same time an opportunity for easy movement. Details of the devices employed for this purpose are shown in Fig. 5. The left-hand section is at the upstream edge of the upstream leaf. The shaded members are bolted in place after the leaf has been otherwise completely assembled and the hinge posts grouted in place. In operation, the built-up member *a* remains fixed, being bolted to the hinge post and sealed to the concrete sill with grout. Member *b*, bolted to the movable weir, is so shaped that when the weir moves the curved portion rotates and maintains a contact with mem-

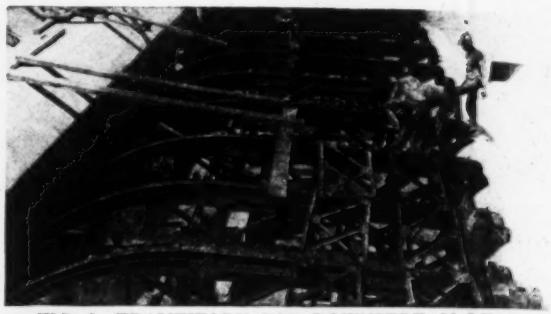


FIG. 3—FRAMEWORK FOR DOWNSTREAM LEAF OF WEIR

ber *a* at all times. Watertight sealing is effected by means of hydraulic packing shown in the recess in member *a*, at the point of contact between the two members.

The center section (Fig. 5) is taken at the downstream sill. At this point there are two galvanized-iron strips set in a fixed position as shown by *c*. They are bolted to an angle which is fastened to the hinge posts and sealed to the sill with grout. There is a leather strip riveted to the inside galvanized strip in such a position as to bear against the under side of the curved member *d*, which is bolted to the frame of the weir. When the weir moves upward to its maximum height, *d* reaches the position shown by the dotted lines. It will be seen that a contact is maintained, in all positions, between that member and the leather strip. Water pressure under the leaf forces the leather tightly against the curved plate. The right-hand section in Fig. 5 shows the seal between the downstream leaf and the concrete side walls. There is a clearance of $\frac{1}{2}$ in. between the steel plate *e* and the face of the wall. A leather strip is fastened to the gate in such a manner as to bear against the concrete. Pressure being always from the under side of the leaf when the weir is in operation, the leather is curved downward, causing it to be forced against the concrete. Added stability is gained for the leather by riveting a strip of copper to its concave side. The copper is 1 in. wide and bent into a quadrant. In the case of the upstream leaf the construction is essentially the same, except that the leather is curved upward against the wall instead of down, headwater pressure always acting from the outside in excess of pressure under the weir.

Great care was necessary throughout construction to secure the required exactness. It is essential not only

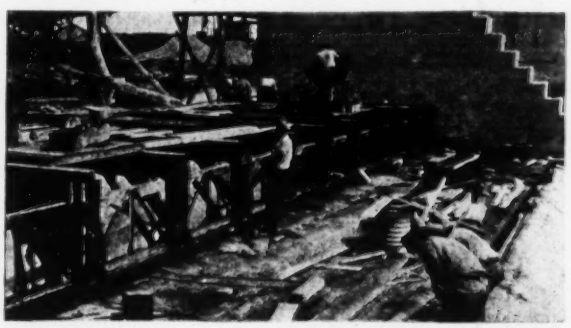


FIG. 4—ASSEMBLING STEELWORK FOR UPSTREAM LEAF OF WEIR
Sealing strip of downstream leaf being attached to sill at the right.

that the piers be exactly 85 ft. apart but that they be perpendicular and at right angles to the two hinge sills. The sills, in turn, must be the required distance apart and parallel with each other. The weirs must be accurately built as to length, and the sides must be at right angles to the line of the hinges.

Method of Operation—Operation of the weirs is controlled at the operating pier. Fig. 6 is a section taken parallel with the axis of the dam on the center line of the operating mechanism for one of the units, showing only sufficient detail to give an idea of the principle of operation. There is a similar arrangement for each of the units. Water from the reservoir enters through a screened opening in the side of the pier near its upstream

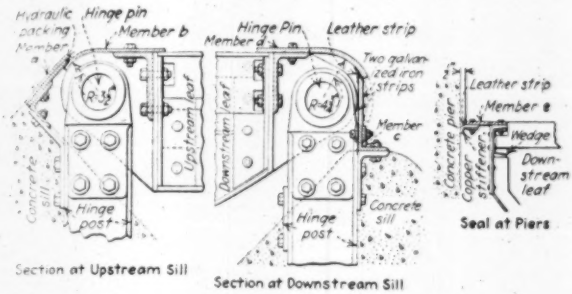


FIG. 5—DETAILS OF THE SEALING STRIPS

end, and thence is admitted to chamber *c* and the under side of the roof weir through a butterfly valve *a*. The butterfly valve is operated by a walking beam and arms connecting it with float *b*.

For normal operation it is desirable to maintain the water level under the roof weir just below the point of the lower leaf, in order to avoid loss of water through the small slit between the two leaves and at the same time afford the necessary buoyancy for holding the weir in an upright position. This is the condition shown in Fig. 2. The water in chamber *c* stands at the same level as that under the roof weir, since there is free communication through the tunnel between the chamber and the under side of the weir. Baffle weir *d* is set at the required height for the maintenance of this level.

If the water rises above the correct level sufficiently to cause any considerable flow over the baffle weir into the float chamber, the float rises and the butterfly valve closes, checking inflow from the reservoir. Normally, the butterfly valve operating arm is so adjusted as to maintain the valve at an angle which permits only enough water to pass to compensate for the slight leakage and for a slight overflow into the float chamber. Drainage of the float chamber is accomplished through a small pipe in the bottom as shown.

Whenever headwater in the reservoir rises above normal elevation, water flows into the float chamber through an opening (not shown) in the upstream wall at crest elevation, raising the float. It will be seen that the lower portion of the support for the walking beam is a pipe, shown at *e*. At its lower end this pipe is carefully surfaced and fitted to a spherically ground seat, shown at *f*. When the float continues to rise after the butterfly valve has closed, that valve becomes the fulcrum, and member *e*, instead of supporting the walking beam, is lifted from its seat. This permits water to flow out from under the roof weir, allowing the weir to subside and reduce the increasing head in the storage reservoir. When the pond level drops again, the procedure is reversed. The float sinks, *e* reseats on *f*, checking the outflow from under the roof weir, and the butterfly valve opens, permitting inflow until the leaves of the weir again rise to full height.

Sluice valve *g* is for the purpose of draining water from under the roof weir whenever it is desired to flush out the chambers. Other sluice valves are installed in the intermediate piers.

The weirs are designed for automatic regulation, but the entire system may be moved to any desired position by manual operation of the several valves.

When the leaves reach their full upright position, links fastened to each leaf and connected by pins straighten out and prevent any further uplift. (See Fig. 2.) In this position the structure assumes a roof-like appearance, from which it receives its name. The leaves may then be locked in place by catches operated from the outside (not shown in the drawing) and all the water may be drawn out of the roof roonf to permit work underneath without lowering the head in the pond.

The question may be raised as to the probabilities of trouble from ice in cold climates with this type of gate. A number of installations have been successful in severe cold weather in Europe. Except in extreme low temperatures, radiation of heat from the body of water under the weir is sufficient to prevent freezing. If desired, the water level under the weir may be raised above

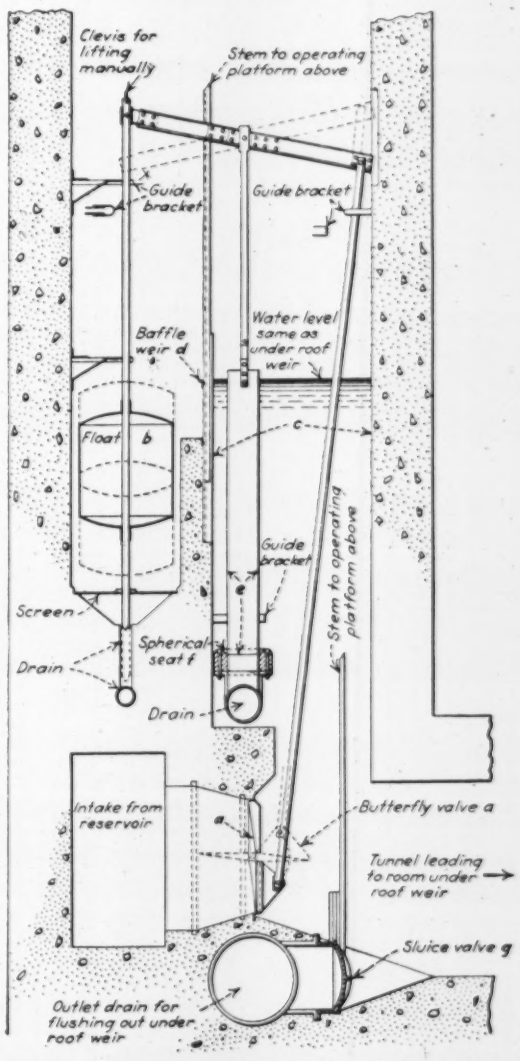


FIG. 6—DETAILS OF THE OPERATING MECHANISM

the tip of the downstream leaf, causing a flow through the slit between the two leaves and down over the exposed outer surface as a means of hindering the formation of ice. The use of air or electrical heating along the downstream sill and the side seals may be resorted to if convenient. In any event, the movement of the weir from its upright position will be downward, away from any ice formation, and as soon as the crest falls, the overflowing water will thaw any accumulation on the weir or concrete.

The "hydraulic roof weir" has been developed and patented by Huber & Lutz, consulting engineers, Zurich, Switzerland. A relation to the principle of the old bear-trap floodgate will be recognized in this type of weir, but there appear to be distinct advantages in this development of the principle. The Texas installations are the largest ever constructed. They are also the first of the kind in this country, although there are more than 60 in operation in various parts of Europe.

The hydro-electric developments here described were designed and their construction was supervised by the Fargo Engineering Company, Jackson, Mich. The Sumner Sollitt Company, San Antonio, has the general contract for the construction, subcontracts for parts of the work having been let to the Price Brothers Company, Dayton, Ohio, and to the R. E. Townsend Corporation, Ann Arbor, Mich. The writer was in charge of construction at the upstream development.

Combating Traffic Vibration and Noise

Possibilities in Dealing With a New Problem of Community Existence—Many Lines of Attack Available

By Stephen E. Slocum
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CENTRALIZATION of traffic and industry in cities has so intensified the destructive effects of vibration and noise as to constitute these conditions a major engineering problem. Various circumstances interact to bring this about. Transit development, as well as growing street traffic, brings a rapid and continual increase in the sources of vibration and noise. Increased traffic facilities are accompanied by increased height of buildings, and since the susceptibility to vibration of steel or concrete structures increases with their height, the effects of vibration are intensified. Modern business conditions increase human susceptibility, moreover, so that vibration and noise become a menace to health and sanity.

There can be no question that noise and alarm are adverse to efficient production, and medical authorities assert that their effect on health is even more serious than outward effects indicate. The abatement of conditions responsible for the economic waste involved in noise and vibration therefore becomes a pressing engineering problem. While realty owners hitherto have been compelled to accept vibration and noise as nuisances beyond control or redress, successful proceedings against the smoke nuisance suggest that the former also may come to be recognized as a valid basis for damage claims or injunction proceedings.

Rail and Pavement Traffic

Vibration, noise and sound are merely three phases of the same phenomenon. When the frequency of a vibration lies below about 30 oscillations a second, it is felt as a tremor or shake; when the frequency is between 30 and 50, the vibration becomes a noise; and when it rises above 50 oscillations per second, the vibration becomes audible as a sound, of increasing pitch, until the limit of audibility is reached at about 15,000 oscillations per second or higher, depending on the individual. Traffic vibrations are in general of low frequency and therefore appear as tremor and noise.

Traffic vibration and noise arise chiefly from rail traffic and pavement traffic. In the former the rolling of steel wheels on steel rails is the chief source of noise, especially where amplified by the viaduct structure of elevated railways or by reverberation (multiple reflection from the walls) in subways. In the case of automobile traffic the principal offenders with respect to vibration and noise are heavy trucks and buses with powerful four-cylinder motors.

The torque of a motor fluctuates, having a peak at each power impulse in a cylinder. For passenger cars with six or eight cylinders the torque is fairly uniform, so that the vibration set up by torque recoil is relatively weak and is practically absorbed by the pneumatic tires before it reaches the pavement. In a powerful four-cylinder motor, however, a large and strongly variable torque recoil is communicated through the wheels to the pavement as a tremor or shake, an effect quite distinct from impact vibration caused by rough pavements. Even on perfectly smooth pavements a heavy four-cylinder truck frequently causes very noticeable vibration in near-by buildings. Two remedies for such vibration effects are: (1) to insulate the substructure carrying the pavement from the foundations of adjoining buildings, as carried out in the Grand Central Terminal zone, New York, and in the new Pennsylvania Boulevard now under construction in connection with the Philadelphia improvements of the Pennsylvania Railroad, and (2) to eliminate the source of vibration by penalizing certain types of trucks and buses or by restricting their use to specified traffic channels.

While steel wheels rolling over steel rails are the most persistent offenders, rail traffic produces innumerable other noises which are not present with automobile traffic, such as rail click at joints in rails, grinding of wheel flanges on railhead, grinding of metal brake shoes, electrical hum, transmission noises, rattle of loose metal parts and resonant vibration of car body acting as a sounding board. Vibration, on the other hand, is caused chiefly by the periodic succession of wheel loads passing over the ties, and by tractive and braking forces between wheels and rails. In viaduct structures, including bridges, the periodic succession of wheel loads may cause vibration directly in the members affected, or vibration may be set up by synchronism with the natural frequency of certain members of the structure. In subways the effect is aggravated by the greater speed at which trains are operated; moreover, noises which are rapidly dissipated in open air become a deafening roar when confined within the narrow limits of the tube. In subway tubes there are also siren effects produced by air turbulence and by the piston effect of trains displacing the air in the tube. These give rise to a new class of

acoustic problems that are peculiar to the operation of subways.

As there are so many and such varied causes of traffic vibration and noise, there is no one remedy which is a general specific for the trouble. Ingenuity and resourcefulness are required to make an effective solution of the problem.

Principles of Noise Reduction

There are, nevertheless, certain general principles of vibration control which serve as guides for research and experiment. Mass damping, avoidance of synchronism, use of insulation for short-circuiting vibration, acoustical methods for absorbing sound, aeronautic methods for reducing turbulence and air pulsation, special motor winding to reduce electrical noises, worm-drive transmission, and many other items of equal importance, contain definite possibilities. In assembling such detail remedial measures there are also two general principles to follow—namely, first to reduce the source of vibration and noise to a minimum; and second, to damp out, isolate, absorb or otherwise nullify the noise and vibration as near the point where it originates as possible. This second item may appear obvious, and yet it is not always recognized in practice. For example, in damping street traffic vibration, the pavement may be so constructed as to act as a damper, or in rail traffic the track foundation may be so modified as to serve the same purpose.

In the line of mechanical improvements for reducing noise, a beginning has already been made in several instances. A "noiseless" street car, involving worm drive, spring suspension of motors, series winding of motors to reduce electrical hum, ball bearings, and the like, has been tried in several places, though the most important items—namely, wheels, rails, track foundation and construction of car body—remain untouched. Experiments carried out five years ago by the London Underground Railway for reducing subway noise and vibration led to the following conclusions, among others:

The loudest sounds are not the ones which cause the most discomfort. The principal sources of noise are wheel rolling, and vibration of sides and roof of car; insulating the car body from the trucks did not remedy matters. Windows are the chief passageways of sound; the remedy proposed was to reduce their size, use thicker glass, keep closed, and secure ventilation through indirect passages or ventilators fitted with baffle plates. All box-like constructions are to be avoided, or to be packed with mineral wool. Asbestos separators should be used between all steel contacts. A floating axle was recommended with radius rods and helical gear drive, though later experience with the "noiseless" street car indicated that worm drive through propeller shaft and double universal joints is preferable. For vibration of car body the solution proposed was to build the car body double and pack the space with cork or similar insulation. Also, the track should be packed as high as possible with fine ballast. Cars should be streamlined, with wind-cutting ends; wheels should be shrouded, with wind scoops at the forward edge.

It is evident that the work done thus far in traffic noise reduction is elementary and fragmentary, but it has opened the way for rapid progress when the subject receives proper attention. The engineering difficulties involved in suppressing vibration and noise are by no means insurmountable, although they call for thorough study. For instance, reducing car-body noises by building the bodies double and insulating the dead space with cork is an expensive and somewhat crude solution of the problem. By exploring instrumentally the vibration of the structure its antinodes could be determined under service conditions and the structure stiffened at these points to alter the natural frequency of vibration and thereby avoid synchronism. As another instance, the London Underground experiments do not seem to have developed any remedy for the rumble caused by wheel rolling, nor does there seem to have been any attempt to check the reverberation from tube walls—the two chief factors in subway noise. The siren effect in subways due to vibration of the air column seems to have escaped attention.

Instruments are now available for measuring the intensity of sound as distinguished from the older type of vibrograph or vibrometer for measuring the amplitude of vibration. The critical amplitude and frequency of vibration necessary to cause physical discomfort have also been experimentally determined. We are therefore in a position to make an engineering survey of actual conditions as regards traffic noise and vibration. Such a survey would serve important ends in determining the source and relative importance of traffic noises and vibration, which is an essential preliminary to any civic scheme of correction; also in determining how far such noises cause physical reactions injurious to health or efficiency; and in case legislation is necessary to promote relief, as in the precedent set by the abatement of the smoke nuisance, in setting up standards by which improvement in conditions may be gaged.

Technically the dynamics of vibration has many features in common with electrodynamics (periodicity, conductivity, synchronism, insulation), and research in vibration control must therefore give prime attention to dynamic effects. Practically this resolves itself into various factors such as the physical properties of vibration dampers and insulators; anti-vibration details of steel and concrete design; dimensioning structural members to avoid synchronism; modification of street pavement construction and track foundations to serve as vibration dampers; improvements in wheels and rails, and similar developments.

Hackensack Bascule Counterweight Removed From River

Utilizing the rising tide and an old freight steamer the 800-ton concrete counterweight of the wrecked Hackensack bascule bridge on the Lincoln Highway near Jersey City, N. J., was removed from the river on Oct. 8, the bridge being closed to traffic for a total time of 12½ hours. The counterweight was dropped into the river when one of the leaves of the bridge failed during lowering on Dec. 15 (*Engineering News-Record*, Dec. 20, 1928, p. 931). The procedure used to remove the counterweight was as follows: The leaves of the bridge were raised to their fully open position, and an old freight steamer was maneuvered over the counterweight while the tide was at flood. The vessel was then filled with water and sunk until at low tide it rested on an even keel on the counterweight. Divers lashed the concrete block to the freighter by means of cables. Then as the tide rose, the water was pumped from the vessel, which, regaining its buoyancy, lifted the counterweight from the bed of the river. Thus suspended from the freighter, the counterweight was towed out of the ship channel and deposited where it would not interfere with navigation. It is planned to use the same procedure later to remove the counterweight to se

Bonds Based on Bridge Income Finance New Toll Structure

Unique Financing Characterizes New Municipal Bridge Across Ohio River at Louisville—Ownership by City, but Earnings Go to Bankers Until Bonds Are Retired

ONE of the major factors of importance attaching to the new Louisville municipal bridge across the Ohio River, which is scheduled to be opened Oct. 31, is the method of financing used. After two general elections failed to bring approval for ordinary tax levy bonds as a medium for financing the structure, an offer by an investment banking house to buy, at a discount, bonds that constituted direct liens on the earnings of the bridge was accepted. In addition to the special method of financing, both low cost and speedy construction characterized the project, which consists of two long cantilever spans, one over the harbor area in Louisville and one over the Indiana chute at the north end of the bridge. A total construction time of one year and five months was required. The cost of the structure, $4,750,000, was divided as follows:

Financing charges and interest during construction	$662,969.12
Real estate costs and property damage	435,594.02
Contract construction cost	3,574,773.14
Administration cost	76,663.72

History of Project—A bridge across the Ohio River at Louisville has been a needed utility for a number of years inasmuch as the only available crossing, other than a ferry between Louisville and Jeffersonville, Ind., consisted of two narrow lanes for vehicular traffic on the outside of the K. & I. Railway bridge. The first effective effort toward securing a bridge was made in 1924 when the city of Louisville had a state act passed authorizing a joint commission between the states of Kentucky and Indiana for building a bridge. This act provided that the city council could determine whether or not it was to be a free bridge or a toll bridge, and also authorized a direct tax levy on the citizens of Louisville for the cost of the bridge; it also approved the use of city funds for preliminary investigation and engineering work.

The question of authorizing bonds for the construction of a free bridge was submitted to the voters in 1926 and was overwhelmingly defeated. In 1927 the question was again submitted to the voters, this time on the basis of a toll bridge, and this proposal also was defeated, but by such a narrow margin that a recount of the ballots was required to settle the question. With these avenues for financing closed, the engineers for the city, Modjeski & Masters, suggested receiving proposals from private investment bankers for the construction of the bridge. Consequently, the Louisville Bridge Commission invited such proposals and received about twenty financing propositions. Most of these proposals were for a privately owned toll bridge which would be constructed under an act of Congress, requiring the bridge to be freed within a limited term of years. Incidentally, most of the proposals requested 30-year terms instead of the 20-year term usually granted by Congress. Several proposals were more favorable, however, and the one that was finally adopted proposed financing the bridge with an income type of bond.

Bridge Income Bonds—The proposition adopted provided that the investment bankers would furnish the money for building the bridge and would receive the earnings of the bridge to pay off the bonds. It was also stipulated that a traffic survey should show that the bridge would earn two times the bond interest and that a proper state act should be passed authorizing the city to issue the type of bonds proposed. Under this plan, the bridge was to be owned by the city and built and operated by the city. The funds for the construction were to be placed in the hands of trustees and administered by the bridge commission, and the earnings of the bridge were to be similarly handled. Bonds were to be called and retired as fast as bridge earnings became available. With the retirement of all of the bonds, the bridge would become free.

The contract with the investment bankers further stipulated that they would pay the city $92 for every $100 bond. These bonds did not create a tax lien of any kind on the city; in fact, no mortgage on the bridge was required by the bankers on the assumption that if the bridge did not earn a return on the investment it was of no value. On the other hand, the bonds comprise a more or less moral obligation on the part of the city, since failure to pay interest on these bonds will reflect seriously on the standing of all its municipal bonds. The bridge bonds bear interest at 4½ per cent.

The city was successful in having a state act passed authorizing the construction of this bridge under the above-detailed plan. The act was approved by the courts in June, 1928, and the first contracts were signed for the construction of the substructure immediately upon the court approval. The procedure that was used involved the writing of a trust indenture and turning over of the funds to a trustee mutually agreed upon by the city and the investment bankers. The funds were disbursed jointly by the bridge commission and the engineers.

Modjeski & Masters, associated consulting engineers, were engineers for the city of Louisville. The bridge was financed by Stranahan, Harris & Oatis, of Toledo, Ohio.

Column Test Completed for the Port of New York Authority

The Bureau of Standards has recently completed compression tests on half-scale models of columns which form portions of the towers of the new suspension bridge to cross the Hudson River between the upper part of New York City and Fort Lee, N. J. These half-scale models are 24 ft. long, with a cross-section of about 160 sq.in. Ten of the columns were tested in the bureau's large testing machine, which has a capacity of 10,000,000 lb. Different kinds of steel had been used in the construction of the columns, and the work has shown that these columns are of very excellent design, full strength of the material being utilized. For instance, the maximum load required to cause failure of the bare carbon steel columns was 5,860,000 lb., whereas the bare silicon steel columns withstood a load of approximately 8,600,000 lb. In addition to these tests on the bare steel columns, the carbon steel columns were tested when incased in concrete; they withstood a maximum load of 8,587,000 lb. It is seen that the concrete added about 2,500,000 lb. to the strength of the unincased carbon steel columns, or an increase of about 40 per cent. It is estimated that the corresponding increase for the silicon steel columns would be about 30 per cent. The results are of interest to engineers, since but little work has been done in determining the strength of structural members approaching these in size.

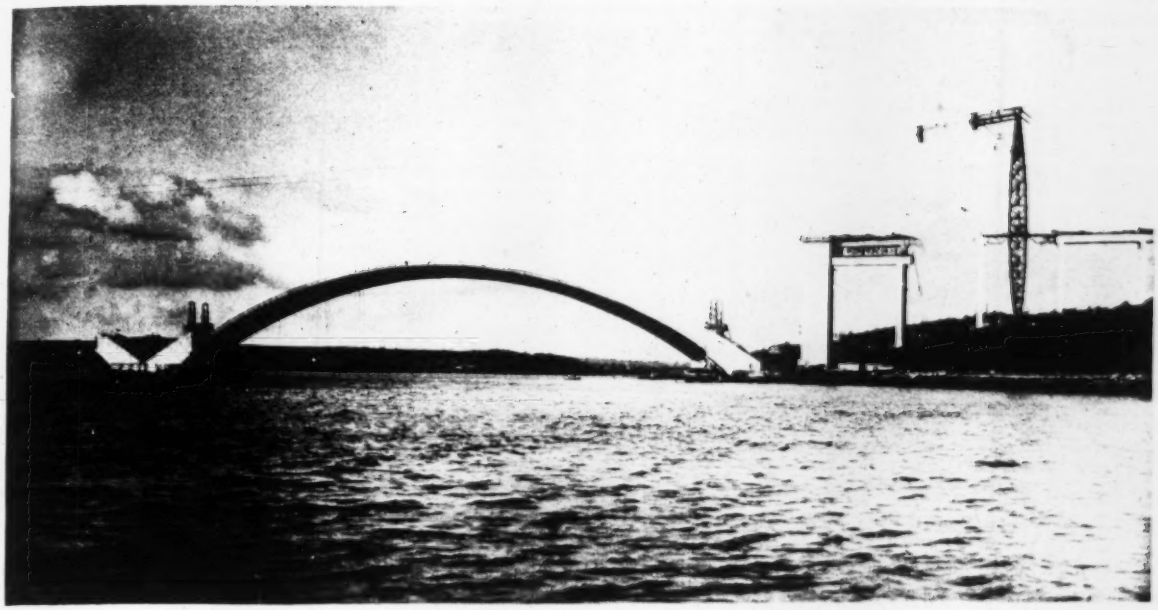


FIG. 1—CONSTRUCTING A 612-FT. REINFORCED-CONCRETE ARCH AT THE ENTRANCE TO THE HARBOR OF BREST, FRANCE
Wood center in place for first span. Double cableway between wood towers carries electric hoists.

Unique Construction Procedure on Long-Span Concrete Bridge Arches at Brest, France

Three 612-Ft. Arches Concreted in Succession on Single Center Shifted by Barges—Box Arch Designed for 1,000-Lb. Load Per Square Inch of Concrete Section—Cofferdams Constructed of Concrete, and Concrete Caisson Used as Diving Bell—Double Cableway With Traveling Electric Hoists Serves Operation

BOLDNESS of unusual character both in engineering design and in construction procedure is exhibited in the building of the Plougastel bridge which is described in this article. While the admiration of the designer is challenged by the slender arches of unprecedented span for reinforced concrete, even greater interest exists for the constructor in the plan of maneuvering the arch centers and in their structural combination of timber and reinforced concrete, in the adaptation of the pneumatic caisson for one pier to diving-bell operations on another pier foundation and in the cableway equipped with a shop-crane type of hoist taking current from the traction cable. Constructors too will appreciate the amount of ingenious detail that entered into these devices and procedures to make them successful. Information for this article has been furnished by E. Freyssinet, Neuilly-sur-Seine, France, designer and builder of the bridge, by correspondence and through a paper by him presented at the last convention of the American Concrete Institute. Limousin & Company are the contractors.

A REMARKABLE concrete arch bridge is being erected at the point where the Elorn River flows into the harbor at Brest, France. Its three arches, each of 612-ft. span between pier centers, are the largest concrete arches yet undertaken. The arches are cellular, the section consisting of an upper and a lower slab connected by four vertical walls, the outer ones of which constitute the arch faces. Unprecedented methods were used in constructing the river piers, the shallower one being put down with a reinforced-concrete caisson used as a diving bell and then floated to the other pier and sunk as a compressed-air caisson. In building the arches, the concrete is poured on a timber

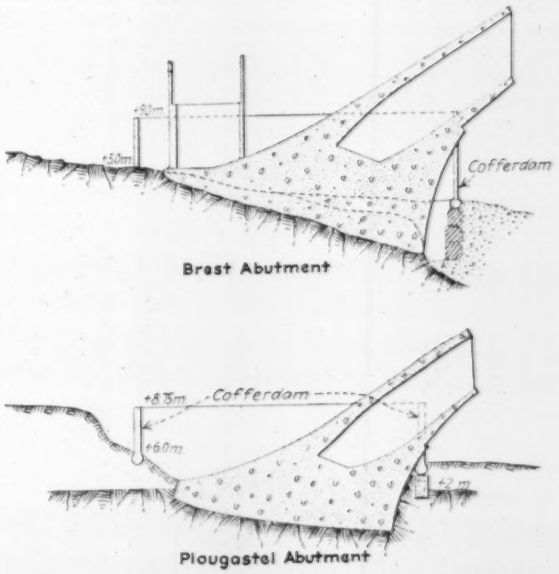


FIG. 2—ABUTMENTS CONSTRUCTED IN CONCRETE COFFERDAMS

center, the ends of which are tied together by cables while it is being floated into place on barges and raised to position by jacks on the piers. In position the ties are loosened and the center acts as an arch. Only one center is being used for the three arches. The concrete is transported from a mixing plant on shore by a cableway of 2,300-ft. span, utilizing the main cable and a copper-core traction cable as an electric circuit for a hoist located in a cabin similar to those used on the ordinary bridge cranes of industrial plants.

At the location of the bridge, the Elorn River has a width of 2,130 ft. at high tide. The tidal range is 26 ft. and the current is occasionally very strong. The contract required that no obstructions should be placed in the ship channel and that this channel should have a minimum width of 564 ft. and a vertical clearance of 118 ft. The use of an arch seemed obligatory for the channel span and it was deemed economical to use two similar arches for the remainder of the crossing.

The arches support a deck of two stories, the lower

FIG. 3—CAISSON READY TO LAUNCH FOR DIVING BELL OPERATION ON FIRST PIER
The crib on the side is a float for decreasing the draft.

of which carries a single-track railway and the upper a roadway 26 ft. wide. At the time most of the accompanying views were taken the foundations were completed as well as short cantilever sections of the arches to an elevation 42½ ft. above high tide; one arch was poured and the centers struck and a second was under construction. At present the three arches are complete and about two-thirds of the timber centering has been removed. The bridge will be in service in about a year.

Foundation Construction—The arches rest on two abutments and two piers founded on rock. The abutments are on land and were constructed in circular reinforced-concrete cofferdams 28 meters in diameter. Sections of the two abutments, one at Plougastel and one at Brest, are shown in Fig. 2. The two piers in the river rise to El. +2.0 meters, zero being the lowest low water. Each of the base shafts supports short cantilever sections of the arches, which were built as part of the foundations and are shown in some of the accompanying

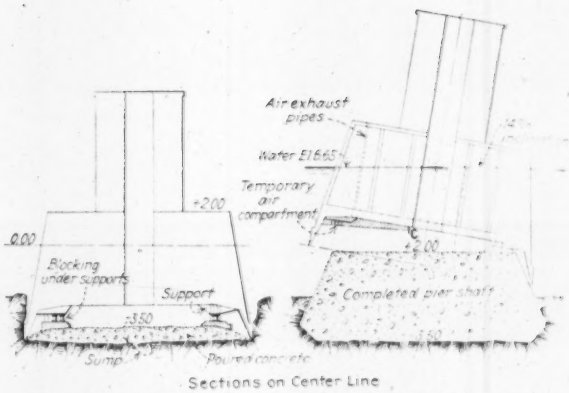


FIG. 4—REMOVING THE CAISSON FROM FIRST PIER
At the left, the caisson, operating as a diving bell, is being raised with jacks simultaneously with the pouring of concrete in the working chamber. At the right, the caisson is being removed from the completed pier shaft by admitting compressed air under one side and floating it away at high tide.

illustrations. Alumina cement was used for the portion of the piers in the tidal range to guard against deterioration of the concrete in sea water. The aggregates were quartzite rock and bar sand, and in the base of the piers 50 per cent of quartzite rubblestone was added in order to reduce the cost and to diminish the heating of these massive parts during hardening.

Caisson Operations—In constructing the two river piers a concrete caisson was used as a diving bell for founding the first pier, a relatively shallow foundation, and later was used in normal manner as a pneumatic caisson for constructing the deeper second pier. Its external shape was that of the finished pier between El. +2.0 and —5.8 meters. Above the working chamber the caisson was divided into compartments for water ballast to control flotation.

The caisson was constructed on land and provided with wooden floats (Fig. 3) to reduce the draft and to improve the stability at the time of launching. In Fig. 3 the caisson is resting on rails in an inclined position just ready to enter the water. At the time of a very high tide air was turned into half of the working chamber, which was divided into two compartments by means

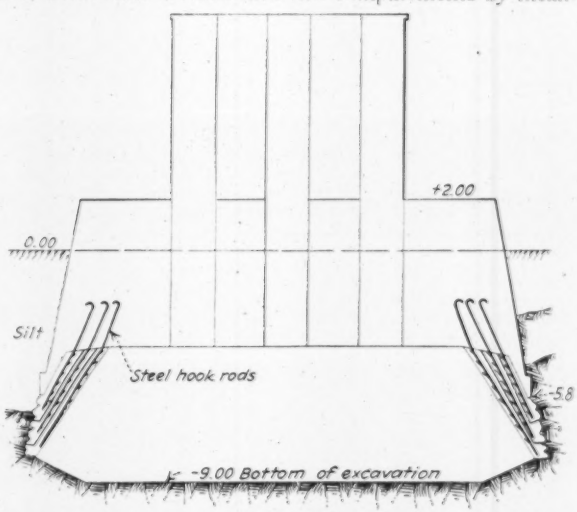


FIG. 5—CONSTRUCTION OF SECOND PIER BY SINKING CAISSON BY COMPRESSED AIR
The cutting edge was stopped at El. —5.8 meters and then underpinned to rock by successive reinforced-concrete piers battered outward; the main excavation was in the meantime carried down to sound rock at El. —9.0 meters.

of a longitudinal partition, thus causing the caisson to float in an inclined position. It was then hauled into deep water, the air was allowed to escape from the working chamber and the frame floats were removed.

For the shallower foundation (Fig. 4) the caisson was sunk onto three pedestals which had been constructed on the rock bottom by divers, the bearing on the pedestals being taken by three reinforced-concrete legs inside the working chambers. In this position the cutting edge cleared the rock all around. Compressed air was then admitted to the working chamber, and men working in water up to their knees lowered the caisson progressively by undermining its feet and their supports, then clearing out the rock from under the cutting edge, and repeating the operation until the cutting edge reached the rock, as shown in the left-hand sketch of Fig. 4. Within the working chamber the pier base was placed, using alumina cement concrete in which as many large stones as possible were incorporated to reduce the heating effect. As the pier base was built up the caisson was raised by means of jacks. When El. +2.0 meters was reached, the caisson was tilted (right-hand sketch in Fig. 4) by admitting air into a temporary compartment under half of the working chamber. Then the caisson was floated off at flood tide.

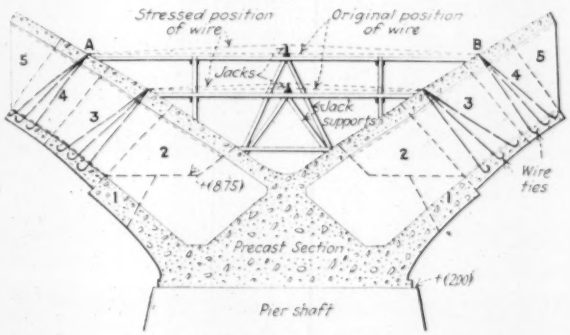


FIG. 6—METHOD OF CONSTRUCTING LOWER PART OF ARCHES

Umbrella section from El. +2.0 meters to +8.75 meters was precast and floated to place. Sections marked 1, 2, 3, 4 and 5 were poured in sequence in forms hung from the completed portions. Wire strands stretched across the pier connecting sections 3 and 4 in the opposite cantilevers were stressed by raising their middle points by jacks.

In Fig. 5 the caisson is shown in place for the deeper foundation, where it was used as a pneumatic caisson. It was sunk in the usual way through the mud and silt to El. —5.8 meters. Here lowering was stopped and the space between the cutting edge and the rock was sealed with concrete around the periphery of the working chamber. After the empty compartments of the upper part of the caisson had been filled with concrete, excavation was continued under the cutting edge in small sections, and small piers were successively poured, being bonded to the concrete of the caisson by reinforcement which had been left projecting at the time of its construction. The small piers were battered outward (Fig. 5) to increase the total base area in proportion to the increased depth, since it was not known at what depth adequate bearing would be found.

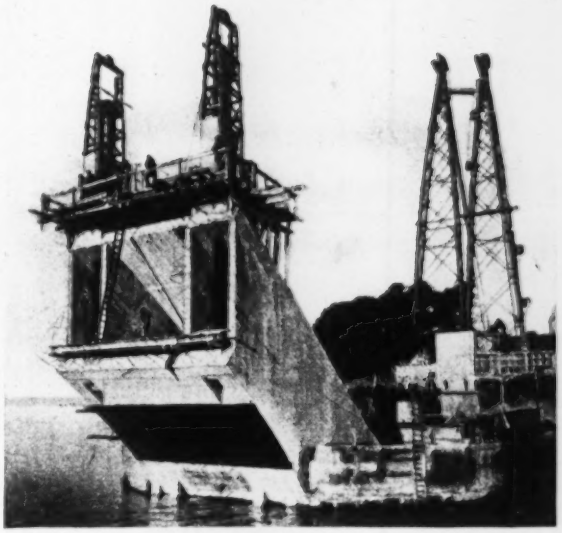


FIG. 7—BREST ABUTMENT SHOWING HOLLOW CROSS-SECTION OF ARCH

The pier tops which comprised the lower part of the arches were precast on shore, floated into position and attached to the shaft at low tide. This section of the pier extended from El. +2.0 to El. +8.75 meters as shown in Fig. 6. On top of these precast units, the sections of the arches marked 1, 2, 3, 4 and 5 in Fig. 6 were built consecutively in forms suspended from the parts already built. Opposite sections 3 and 4 were connected across the pier by steel wire strands put under stress, after the concrete had set, by jacking up their middle points. These ties relieved the cantilever stress in the umbrellas and prevented the opening of cracks.

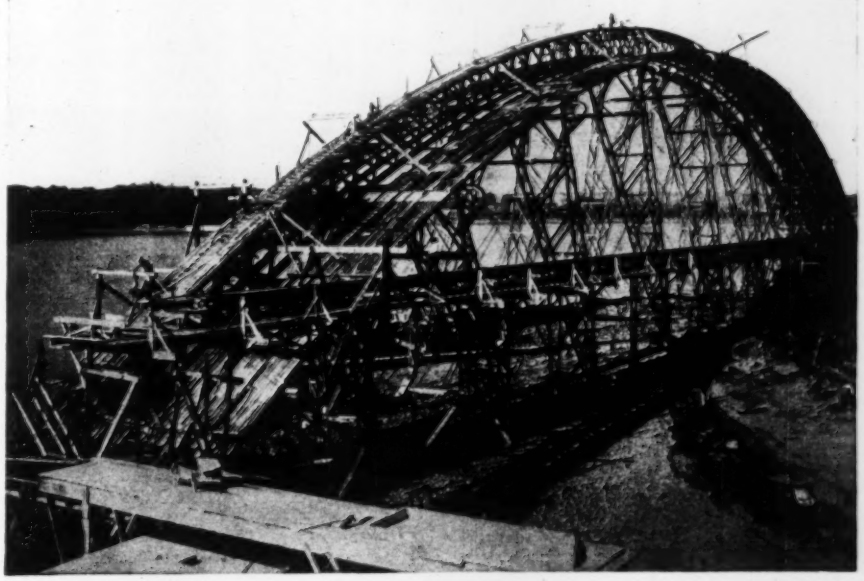


FIG. 8—BUILDING THE ARCH CENTER ON LAND

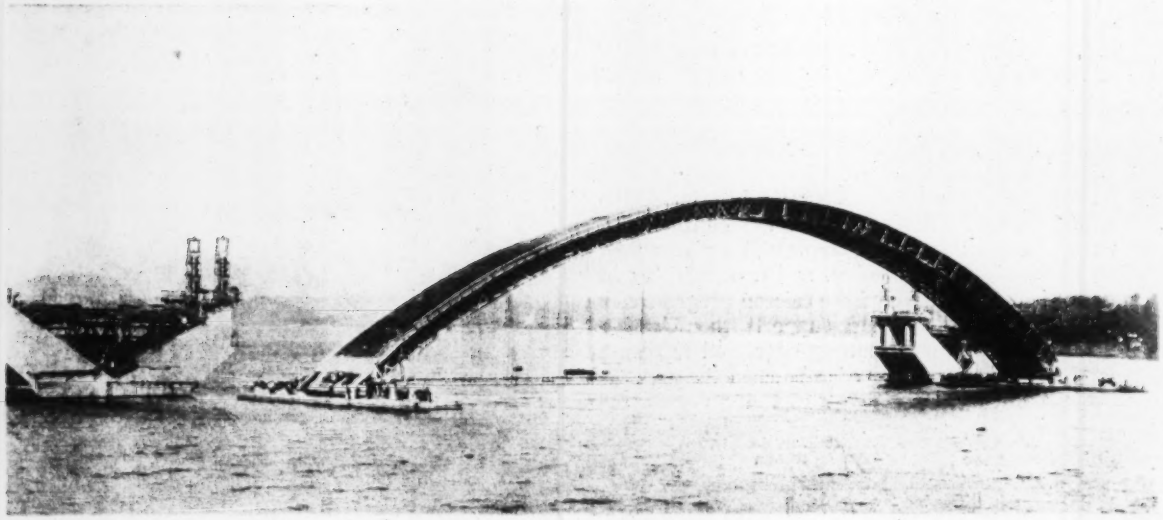


FIG. 9—FLOATING THE ARCH CENTER INTO PLACE ON BARGES

Note the horizontal cable ties. Small towers on ends of cantilever sections of piers carry hydraulic jacks for lifting and holding the center until it could be sprung into position as an arch between abutments formed by offsets on the arch cantilevers. The cross-section of the arch showing its hollow construction is visible at the right.

Arch Structure—The arches have a width of 31.1 ft. with a maximum depth of 16.5 ft.; they are of box section (Fig. 7), having vertical walls binding together the intrados and extrados slabs. The thickness of the walls increases toward the abutments, reaching a maximum of about 3 ft. As shown by Fig. 12, the extrados slab over the central cell is discontinued for some distance on each side of the crown to permit the passage of the railway between the side cells.

All calculations were made on the basis of a fixed arch of 590-ft. span with a rise of 110 ft. The maximum stresses per square inch in the arches are as follows: 453 lb. from the dead load of the arch, 142 lb. from the dead load of the deck, 284 lb. from the live load of vehicles and trains and 213 lb. from temperature variations in the arch. Thus the total maximum stress is approximately 1,000 lb. per sq.in. Internal tension in the arch from permanent shortening will be relieved by 28 jacks which have been installed in niches in a joint at the crown.

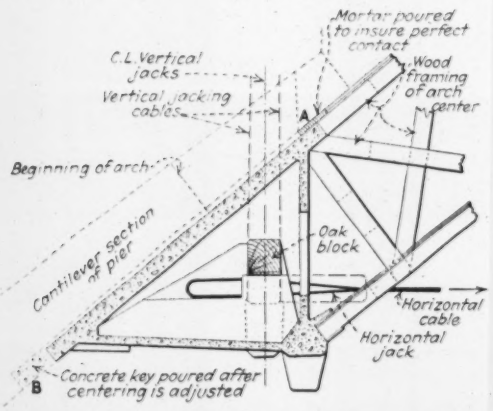


FIG. 10—DETAILS OF LOWER END OF ARCH CENTER

Although center is constructed of wood, its ends are of reinforced concrete. Horizontal and vertical support is furnished by jacks until the center is placed against its abutments at *B* and concrete poured here to convert the center into an arch.

The neutral axis of the arch conforms exactly to the pressure line of the dead load. With the supports for the deck spaced 39.4 ft. center to center, this pressure line has a distinctly polygonal form, and in order to preserve a good appearance the intrados of the arch was made a continuous curve. The polygonal extrados is not visible from the sides because of the continuous curve of the arch face walls.

The arch concrete contains on an average 1.9 bbl. of portland cement per cubic yard; the aggregate is four parts crushed quartzite, one part sand residue and one part bar sand. This concrete, it is stated, "will easily attain 8,500 lb. per sq.in. at the placing in service of the work," giving a ratio of about 8 between the ultimate strength of the concrete and the stress to which it will be subjected. Steel reinforcement is used only because of possible secondary stresses; its proportion is small, being approximately 37 lb. per cubic yard of concrete.

Arch Construction Plan—The basic unit of the construction plant is a specially built cableway of 2,260-ft. span, which is used to place concrete and steel in the arches and to unload boats of material anchored in the channel.

The bridge site is exposed to high winds, and this fact, coupled with the slow operation of the cableways which had been previously used by the engineer and contractor, led him to design a special unit. As may be seen from the accompanying illustrations, it actually consists of two cableways, about 25 ft. apart, each with two cables of 2,260-ft. span suspended between wood towers

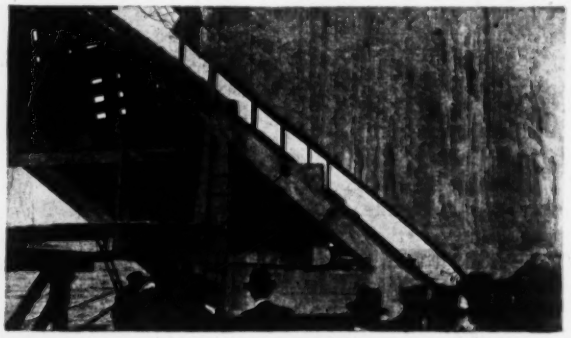


FIG. 11—CENTER BEING RAISED INTO POSITION BY VERTICAL JACKS

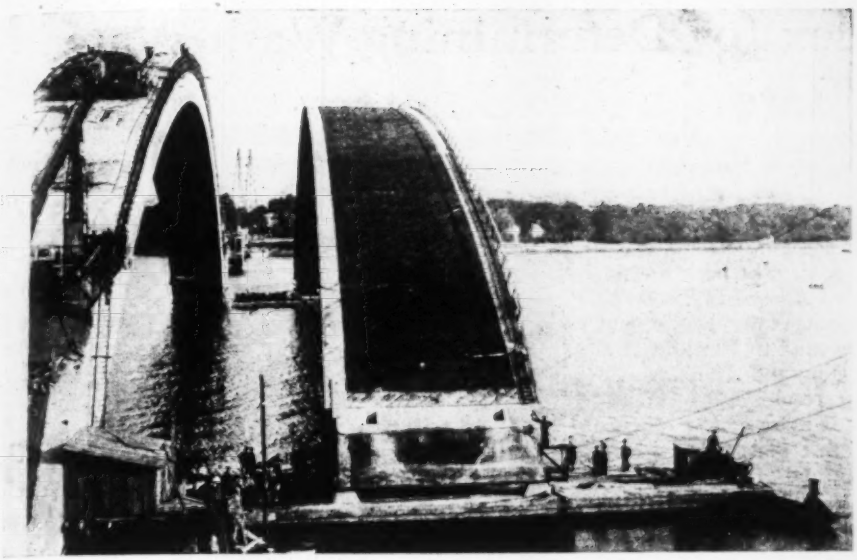


FIG. 12—REMOVING ARCH CENTER PREPARATORY TO PLACING SECOND ARCH

Note the concrete end of the center with the holes through which the slings from the hydraulic jacks are passed. One of the jacks is visible on the arch at the left. Note also how the extrados of the arch is discontinued at the crown to permit passage of the railway tracks. In the distance may be seen the twin towers of the cableway.

180 ft. high. A carriage with control cabin (Fig. 13) and a 4.5-ton hoist operates on each cableway. The cables are held under a constant tension of about 65 tons by counterweights, and are approximately 250 ft. above low tide.

The carriage is moved by a ½-in. traction cable, power being supplied by a 100-hp. semi-diesel engine on a platform on one shore. A 50-hp. portable engine is available for emergencies. The traction cable is fitted with a copper core, so that it may act as the return line for the 220-volt electric circuit through which the hoist is operated; the cableway itself is insulated and forms the other half of the circuit. These carriages have run for almost three years at a speed of 22 to 35 ft. per second without trouble or accident and have transported more than 26,000 cu.yd. of concrete as well as all steel reinforcement and forms. They are said to maneuver easily even in a high wind, and to permit unusual speed and precision of handling.

Design of Center—As already stated, the arch center is an unusual combination of timber and reinforced concrete. One center was used for constructing all three arches. It is an arch having an extrados and an intrados about 8.2 ft. apart joined by single-plank lattice bracing. The joists of the extrados are butt-jointed and form a continuous arch slab 32.8 ft. wide and 0.7 ft. thick. In the intrados the joists are so grouped as to form eight ribs connected by bracing. The butt ends of the intrados joists are stopped 1½ to 2 in. apart and the space is filled with rich cement mortar, which is claimed to produce a highly incompressible joint. On the extrados, two layers of ¾-in. planks are nailed at an angle of 45 deg. to the axis of the arch, to assure rigidity against wind forces. Each end of the center is formed of reinforced concrete. It was built on land (Fig. 8) and was floated to place on barges after its ends were tied together by horizontal cables.

Use of Centering—At each pier and abutment, cantilever portions of the arches about 52½ ft. long were built along with the foundations as explained previously. These cantilevers served as a means for supporting the center. Two holes were left near the ends of the cantilevers extending through both the extrados and intrados slabs and matching similar holes in the concrete end portions of the center (Figs. 10 and 12). Over these holes and on top of the cantilevers there was erected a system of hydraulic jacks carrying slings passing through the holes in the arch to lift and support the center until it could be sprung into place to act as an arch. Additional adjustment is provided by screwjacks acting on the horizontal cable ties.

To place the center, after raising it off the barges, a bed of mortar is placed between it and the end of the arch umbrella at *A* (Fig. 10). Then by slacking off the horizontal jacks and tightening up the vertical jacks the center is held free while its concrete abutment is poured at *B*. When this abutment has set, the center becomes a self-sustaining arch and the two sets of jacks are slacked up.

The centering was removed from the first arch 48 hours after the concreting was finished. Four months elapsed between the first and second installations of the center; the second placing was accomplished in less than three hours in spite of a strong wind.

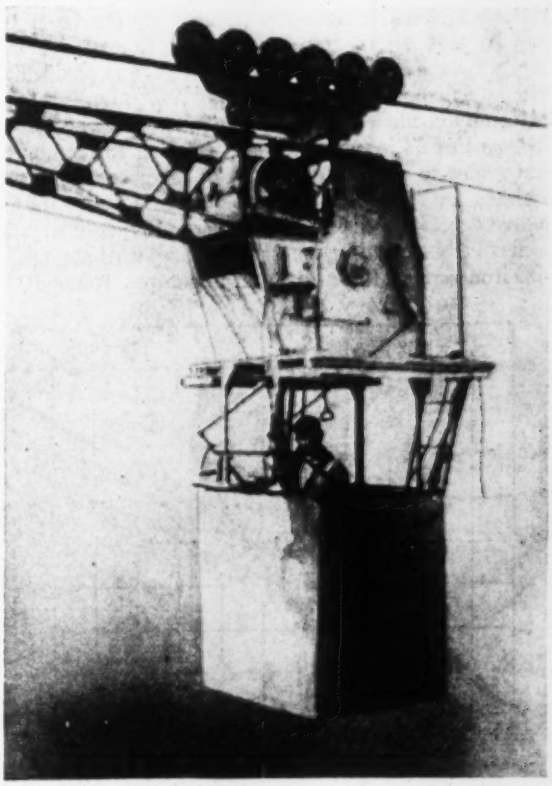


FIG. 13—CABLE HOIST WITH OPERATOR IN CABIN

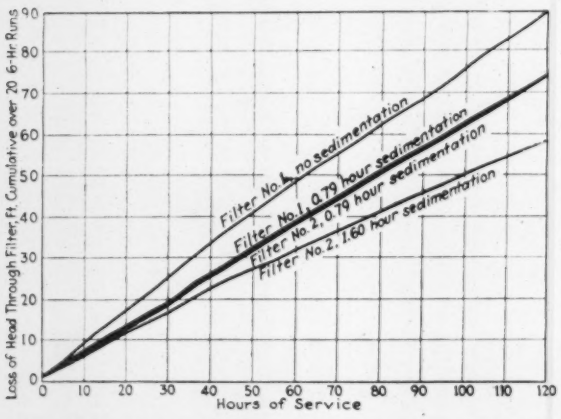
A New Index for Determining Wash-Water Rates in Rapid Filters

Detroit Investigators Find Sand Expansion Better Than Wash-Water Rise as a Criterion of Effective Cleaning

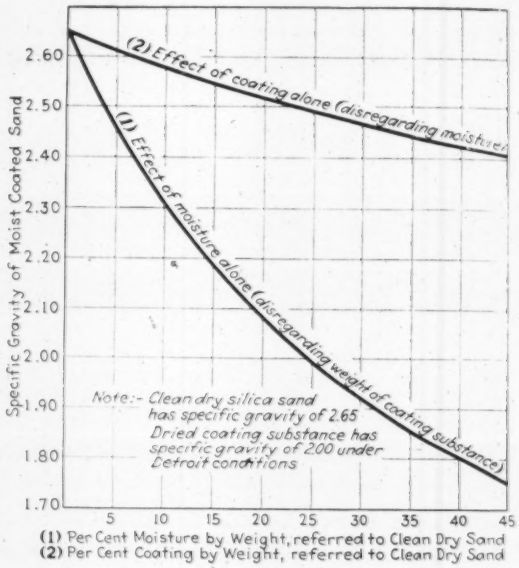
PERCENTAGE of sand expansion instead of rate of rise of wash water in the process of back washing rapid filters is the new criterion proposed by two filtration investigators in the Detroit Water Department. Once clean, an expansion of the sand to 50 per cent or more of its depth prevented coating and shrinkage permanently. Consistent bacterial results were obtained with the clean sand, which fact is more or less opposed to the usually accepted theory that the sand bed must ripen, meaning that around each sand grain a gelatinous coating must gather. Sand in the filters of the Detroit system was inexpensively cleaned with lye and repeated hosing. These filters then gave good results and in washing showed a sand expansion much less than when dirty. As sand expansion varied greatly with the temperature, a sand-expansion indicator has been devised consisting of a float riding on top of the expanded sand surface. The expansion depends for its value upon the rate of flow of wash water, temperature and size of sand grain.

These rather startling conclusions were presented to the Central States Section of the American Water Works Association at its Detroit meeting, Sept. 17 to 19, by Robert Hulbert, senior chemist, and Frank W. Herring, assistant civil engineer, both of the Detroit Department of Water Supply.

The experimental work was concerned more particularly with sedimentation, but was diverted to the washing problem by inefficient, non-consistent results from two 4x7½-ft. test filters run at 160,000,000 gal. per day. They were the end processes of two complete purification units. Effective sand size was 0.55 mm. and the uniformity coefficient 1.35. The depth was 27 in. and a freeboard of 34 in. was allowed. Coating formed on the sand grains to an average weight of 7 per cent (referred to clean, dry sand) with the top ½ in. at 17 per cent and an average, to a depth of 6 in., of 13 per cent. By mechanically churning the sand during washing with a ¼-in. iron screen, fastened to an angle-iron frame 10 in. square and held in a horizontal position, the mud balls, mud banks and loose mud were all removed and the top sand coating showed but 1.4 per cent of coating. The sand surface was covered with a ¼-in. layer of dirty coagulum and mud. Underneath this typical "Schmutzdecke" the sand was as clean as that found on a beach.


Loss of Head Through Filter, Ft. Cumulative over 20 6-Hr Runs
Hours of Service
Filter No. 1, no sedimentation
Filter No. 1, 0.79 hour sedimentation
Filter No. 2, 0.79 hour sedimentation
Filter No. 2, 1.60 hour sedimentation

REGULAR CUMULATIVE LOSS-OF-HEAD CURVES OVER TWENTY SIX-HOUR RUNS AFTER SAND CLEANED


Specific Gravity of Moist Coated Sand
(2) Effect of coating alone (disregarding moisture)
(1) Effect of moisture alone (disregarding weight of coating substance)
Note:- Clean dry silica sand has specific gravity of 2.65
Dried coating substance has specific gravity of 2.00 under Detroit conditions
(1) Per Cent Moisture by Weight, referred to Clean Dry Sand
(2) Per Cent Coating by Weight, referred to Clean Dry Sand

EFFECT OF MOIST COATING OF SAND IN REDUCING THE SPECIFIC GRAVITY OF THE COMBINATION

To avoid the strenuous labor of churning, which was not practicable for large filters, the washing rate was raised to 43-in. vertical rise per minute, resulting in a sand rise of 16.3 in., or 60 per cent. Never again did the two filters show any tendency to become muddy, collect mud balls or show shrinkage cracks. The sand grains remained free from coating. The wash water cleared within two minutes to such an extent that the suspended sand surface could be plainly seen.

Shrinkage—The cracking phenomenon seems to be due to unequal loss of head and a horizontal movement of the water over mud shelves that formed at the gravel line. The water squeezes together the sand grains with their plastic, moist, gelatinous coat. It is held that while the coating may not be the cause of the shrinkage, it makes shrinking possible.

Loss of Head—As soon as the filters were clean the initial loss of head which, before cleaning, had varied from 1.5 to 2.5 ft., now became constant at 1.0 to 1.1 ft., with the curve of increase a straight line.

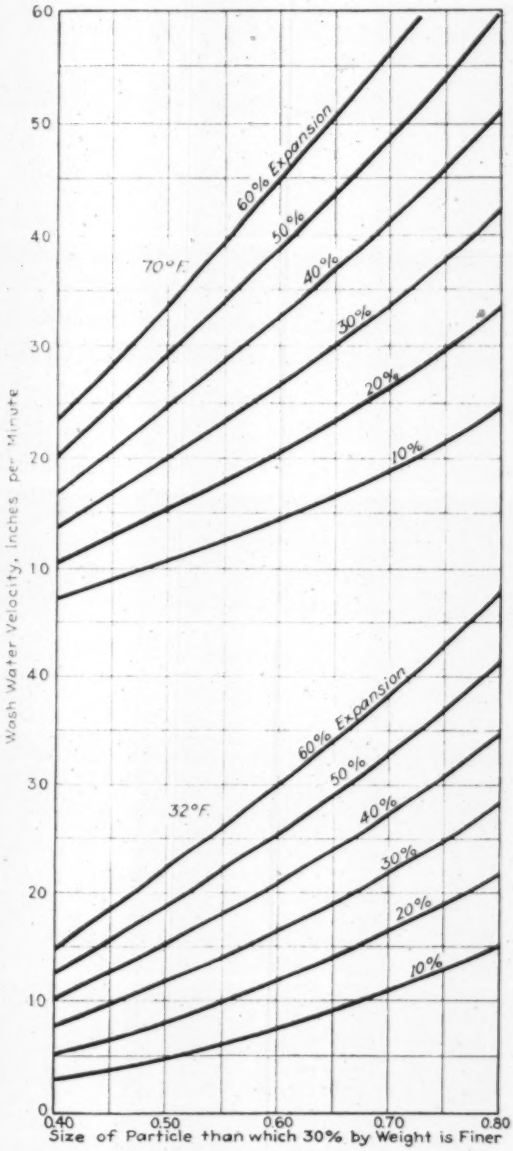
Sand Rise—Prior to cleaning, some sand was always washed out with the 28-in. rate of washing used. After cleaning, the top of the sand never came half-way to the gutter weirs, 34.5 in. above the normal sand surface, a fact that is most encouraging to those who fear loss of sand with high washing rates. The reason is that the specific gravity of the combined sand grain and adhering

gelatinous coating is much below that of the sand, less than 2 instead of 2.65 for a clean sand.

In percentage of wash water the investigators concluded that about 4 per cent was essential, or about 1½ minutes' washing.

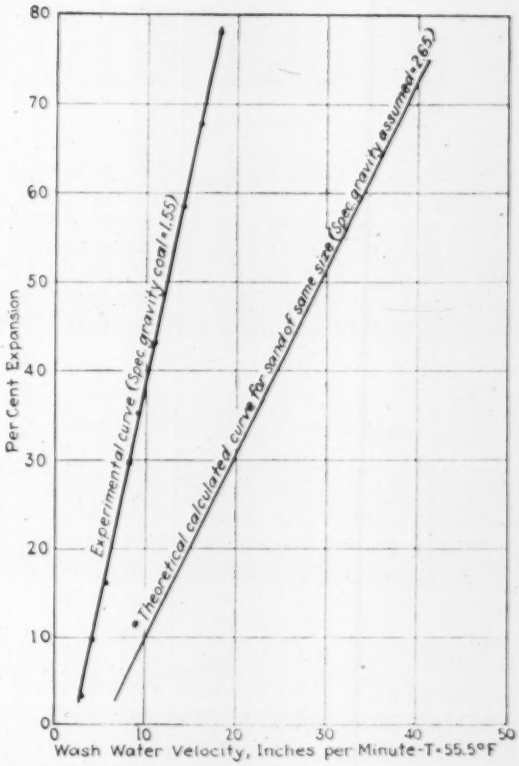
Cleaning Old Beds—An economical and a practical method of cleaning the sand in place in nine old beds was carried out at a cost of $60 per 100 yd. of sand against a replacement cost of $1,300.

A solution of caustic soda or lye is made on top of the filter by sprinkling the contents of a 400-lb. drum over 500 sq.ft. of filter area and floating it to an 8-in. depth to give a 2 per cent solution. After stirring to make a uniform strength the solution is drawn into the bed, leaving it about 4 in. deep over the sand. At the end of 24 hours the volume is again reduced, bringing the liquid to the sand surface, where it is left for 24 or 48 hours.



WASH-WATER VELOCITY REQUIRED TO EXPAND VARIOUS SANDS AT 32 AND 72 DEG. F. TEMPERATURES

The 30 per cent size gave more consistent results than the usual 10 per cent effective size.


Per Cent Expansion
Wash Water Velocity, Inches per Minute-T-55.5°F
Experimental curve (Spec. gravity coal=1.55)
Theoretical calculated curve for sand of same size (Spec. gravity assumed=2.65)

COMPARISON IN EXPANSION QUALITIES OF COAL FROM DENVER FILTERS WITH SAND OF SAME SIZE

The caustic solution is not very efficient in dissolving the alumina, but it honeycombs and softens the coating, making the subsequent scouring easier. The spent lye is washed out and water under 80 lb. pressure through a 1¼-in. nozzle is played onto the sand surface, turning it over to a depth of 8 to 12 in. in successive trenches. An area of 1,000 sq.ft. can be covered in eight hours, and at least three times over is essential to reduce the coating of the top 6 in. of sand to 5 per cent from the original 12 to 15 per cent.

Sand Expansion, the New Index—Since it is the percentage of expansion and not the so-called "high-velocity wash" alone that gives the opening-up effect, permitting agitation while in suspension, which loosens the dirt, sand expansion would seem to be the more logical index.

Experiments indicated that 50 to 60 per cent expansion was satisfactory. In the large plant at Detroit 35 per cent was not enough, and it is considered doubtful if 40 per cent will keep the sand clean. Somewhere between 40 and 45 per cent is held to be the minimum for clean sand of the size used at Detroit.

Instruments—Three useful instruments were devised for measurement of sand expansion. The first is a simple block of wood, 5 in. square, on the end of a graduated pipe, used to obtain the gravel elevation during washing. The second is a similarly graduated rod with a bent hook carrying a 50-candlepower, 6-volt, electric bulb to find the surface of the expanded sand. It will locate it within ⅛ in. A sand-expansion indicator is the third instrument. It also indicates the top of the suspended sand and does so by means of a float riding on top of the sand. If desired, it can be arranged to indicate the depth on the operator's table so that he can

adjust the wash to any height desired. By observing this instrument adjustments can be made independently of temperature and sand characteristics.

From the practical standpoint, the authors stated, the research points to the following conclusions for the designer: Sand should be chosen for its suitability as a filtering medium. The expansion necessary to keep the beds clean should then be decided upon and a wash system designed accordingly.

* * * *

Benefits Derived by Varying Wash-Water Rates With Changes of Water Temperature

Abstract of article presented by W. C. Lawrence, superintendent of filtration, Cleveland, Ohio, in discussion of the foregoing paper.

After two years of operation the Baldwin filters of the Cleveland (Ohio) purification plant began to go bad in the late summer of 1927. I was not surprised, having had charge of the Division Ave. filter plant since it was first put into operation in 1917. I had experienced somewhat similar bad filter conditions every year. At the Division Ave. filter plant I tried prechlorination, washing with longer time periods, raking the sand and digging up around the edges of the beds to loosen the sand, taking out the sand and passing it through ejectors to scrub the dirty grains, even taking off the top surfaces and replacing with finer sand, but all to no avail. The beds would return to a poor condition after passing through a summer, when we always have practically no turbidity but a high content of organic matter and microorganisms.

At the Baldwin plant I was surprised to note the sand piled up around the sides of the filters to a certain height and then occasionally it caved in and caused a bad filter effluent. This bewildered us, since at the Division Ave. plant we experienced a similar piling up and cracking of the beds, but no caving. Both plants have filters of the same area, a very similar strainer system, equal wash-water pressures and in general almost the same conditions, except the size of the sand. Original sand size at Division Ave. was 0.45 mm. and at Baldwin it is 0.38 mm.

The treated water received by the filters at both plants is practically the same, with the exception that the raw water delivered to the Baldwin plant passes through the Fairmount reservoir (an open reservoir with a detention period of 16 to 24 hours), which during the summer months greatly increases the organic matter. This increased quantity of organic matter and the finer sand seemed to cement together with such tenacity that the wash water could not break through and would therefore be diverted toward the center of the bed. This eventually hollowed out a hole and undermined the piled-up portion of the bed. After reaching a certain size the pile would collapse, leaving a hole and exposing the surface of the fine gravel. This collapse would take place when the filters were in operation, which meant that there was a downward suction. At this time unfiltered water would readily pass through and the effluent samples would show poor results.

After experiencing the filters breaking in this manner, about the late summer and early fall of 1927, I was fortunate in receiving a copy of the formula which Mr. Hazen devised for filter washing, in which expansion was expressed in terms of temperature and sand size.

As a result of experimental work in which the Hazen formula was checked, it was decided to increase the rate of wash water at both the Division Ave. and the Baldwin filter plants during the year 1929 as the temperature of the water increased, maintaining at the Division Ave. plant about 40 per cent and at Baldwin a 50 per cent expansion. At the Division Ave. plant the maximum wash water obtainable was a 29-in. rise. But at Baldwin we have been able to continue through with our program. The wash-water system will give a 39-in. rise of water, which is the maximum required for a 50 per cent expansion at the water temperature of 73 deg. F., the maximum water temperature for this year. The water has now (September) reached this temperature and the 24-in. wash-water valves are practically wide open, resulting in a 36-in. rise per minute.

The schedule which we are using for washing filters at the Baldwin plant is as follows:

Range in Temperature, Deg. F.	Rise in Ft. Per Min.	Time
32 to 42	24	Jan. 1 to April 1
42 to 52	28	April 1 to May 14
52 to 62	32	May 14 to June 5
62 to 72	36	June 5 to July 18
72 to max. temp.	38 to 39	July 18

After increasing the rise to 39 in. it was found that by the time the wash-water valve had reached its full open position sand was being lost, so we immediately cut back to the 36-in. rise. This loss of sand would probably not have taken place had the sand been perfectly clean, but because of the organic matter surrounding each sand grain, the specific gravity was less than for clean sand and therefore the sand floated over the steel weir plates. The 36-in. rate scoured off the organic matter in fine shape.

With a long pole to which shallow copper cups, $\frac{1}{4}$ in. deep, were attached and spaced around the pole in a spiral fashion so as to have the tops of the adjoining cups about $\frac{3}{8}$ in. apart, the rise of the sand bed was measured to determine the sand expansions.

From an operating point of view the following results have been accomplished: The appearance of the beds has been greatly improved; the piling up or cracking around the edges has been eliminated. Thirty-six per cent longer filter runs and 16 per cent saving in wash water over the previous year have been effected. Bacterial results on the filter effluent water have not improved this summer, due to the mud accumulation being scrubbed off, which allowed the enmeshed bacteria to pass. Better results are expected from now on. Costs have been reduced, due chiefly to the saving of costly wash waters. No additional equipment is required to produce better beds and it is likely less chemicals will be required when the beds are maintained continuously in good condition. The simplicity and ease of operation make this method very desirable and applicable.

Object to Paying Twice for Improvements

A curious and apparently unique provision of the statutes of Virginia was declared unjust and steps for its change taken at the meeting of the Virginia League of Municipalities on Oct. 16. Under the law, when unorganized areas are annexed to a city, the city thus enlarged must pay to the county the cost of existing public improvements in the annexed area. It is urged that this is unjust because the taxpayers in annexed areas have to help pay for improvements they have already paid for. It is stated that recent annexation of 4 square miles to Alexandria, to take effect Jan. 1, 1930, will require a payment of half a million dollars to Arlington County, under the law in question.

Serious Defects in Foundation Rock Stop Work on San Gabriel Dam Project

Board Declares Site Unsafe for High Dam—Wide Zone of Faulting and Crushing on Line of Toe Is Intersected by Another Fault in Area of West Abutment

DEFECTIVE rock foundation conditions have been revealed by the excavation for the San Gabriel dam, under construction for the Los Angeles Flood-Control District. Following the great rock slide on the west hillside on Sept. 16, which brought down about 200,000 cu.yd., the district appointed a board of engineers and geologists to study the condition of the rock. On Oct. 14 this board reported that the foundation conditions are so serious as to show that "a safe dam of the proposed height cannot be built on this site." A brief news statement of the findings was published in last week's issue, p. 667.

The board consisted of Louis C. Hill, of Los Angeles, and A. J. Wiley, of Boise, engineers; and Robert T. Hill and C. F. Tolman, geologists.

Construction of the dam began last March under a contract awarded last December after nationwide competition of bids. The contemplated structure is a concrete gravity dam 432½ ft. high above streambed and about 500 ft. high above the assumed foundation and level, to store 240,000 acre-ft. Strong controversy surrounded the planning of the project and the scheme was subjected to bitter attack at various times during the past seven or eight years, but the technical opposition, as well as hostile litigation, was finally cleared away and the project put under contract.

The preliminary studies included both geological investigation of the site and exploration of the abutment rock by borings and drifts, both leading to the conclusion that the site was in every way suitable and safe for a high dam. Under the contract about 675,000 cu.yd. of total excavation was contemplated. Work at the west abutment soon developed such extensive areas of loose and broken rock, however, that by Sept. 16 the abutment excavation alone totaled 650,000 cu.yd. On that date a slide occurred at the west abutment which brought down about 200,000 cu.yd. Construction work was at once stopped and further explortaion of the abutment rock by shafts and tunnels was begun. This showed such unsatisfactory conditions that the board of engineers and geologists was appointed to consider them.

Essential parts of the board's report follow:

Character of Rock

The stripping of surface material from the abutments of the San Gabriel dam site has furnished a wealth of geological data not available to those who examined the site before excavations were started.

The foundation rock is a dense diorite gneiss, cut by small dikes of white alaskite and a few dikes of dense brown to black diabase.

The unweathered diorite gneiss at the dam site is a dense "live" rock of satisfactory character for foundation where it is not affected by fracturing, shearing and faulting.

Rock at East Abutment

On the east side fairly satisfactory rock has been uncovered, although some northeasterly cross-faulting has been observed which will reduce somewhat the strength of the foundation rock. The sound rock is terminated on the north and south by severely fractured material. On the south the fracturing is that of the main fault zone to be described presently. On the north a system of fracturing, accompanied by deep weathering, has ruined the rock for foundation purposes. Hence no shifting of the dam site upstream or downstream is feasible.

Main Fault Zone

A wide belt or zone of faulting extends from the east outer bank of the San Gabriel River, just south of the excavation line, diagonally across the flood plain and the west side abutment in approximately a north 75 deg. west direction. From near the center of the flood plain to near the top of the west side excavation its course approximately coincides with that of the toe of the dam.

The general course of this fault zone is indicated by strong fractures seen in the faces of the exposed outcrops, and seams of thick gouge along fault lines which have been encountered at all depths in the excavation and are now well exposed in [several tunnels and shafts].

The northernmost fault face of this zone was exposed in the mouth of the small gully which truncates the center of the west side of the dam site. The lower part of this gully has been removed in the present excavation, but this exposure was observed by one member of our board before stripping operations were started. This gully is excavated in the weak crushed material of this fault zone.

Excavations have shown that this zone of maximum crushing is 100 to 150 ft. wide.

On the east side of the river a fault face is exposed 50 ft. south of the excavations, and a fractured zone 150 ft. wide is indicated by the shearing at the south end of the excavation at the river level and by the small gully southeast of the fault.

Where this zone crosses the river, closely approximate to the toe of the dam, the drill holes show a slightly fractured condition of bedrock.

North Side Fault

The most prominent single fault plane at present exposed in the west side excavation bounds the pit on the north; hence the designation "north side fault." This is boldly exposed where the north line of the excavation intersects the west side of the flood plain of the San Gabriel River near the junction of the East and West fords. The excavations have been carried up to this fracture, thus exposing a large area of this polished surface, which is accompanied by a parting of gouge and has well-developed fault striæ.

The strike swings from North 45 deg. east at the east end of the exposure to North 70 deg. east of the west end and the dip averages 55 deg. to the southeast.

Several widely spaced shear planes are parallel to this main fracture, and at the crossing of this system with the main fault zone described previously is the mass of completely crushed rock which is being removed from the center of the excavation on the west abutment.

The former presence of over 50,000 cu.yd. of crushed rock material at that locality before its recent removal by the steam shovel without the aid of shooting except in rare instances attests the extent of the crushing.

The two main systems of faulting just described are not joint planes opened up by weathering. Were this so, they would becomes planes of closed or incipient fracture below the zone of weathering. Of course, near the surface rock blocks are softened by weathering and the individual blocks become harder with depth, but the fractures will continue with depth. They all show polished surface, gouge and fault striæ, which are evidences of earth movements. They are as numerous and prominent in the deepest portion of the excavations as at the surface.

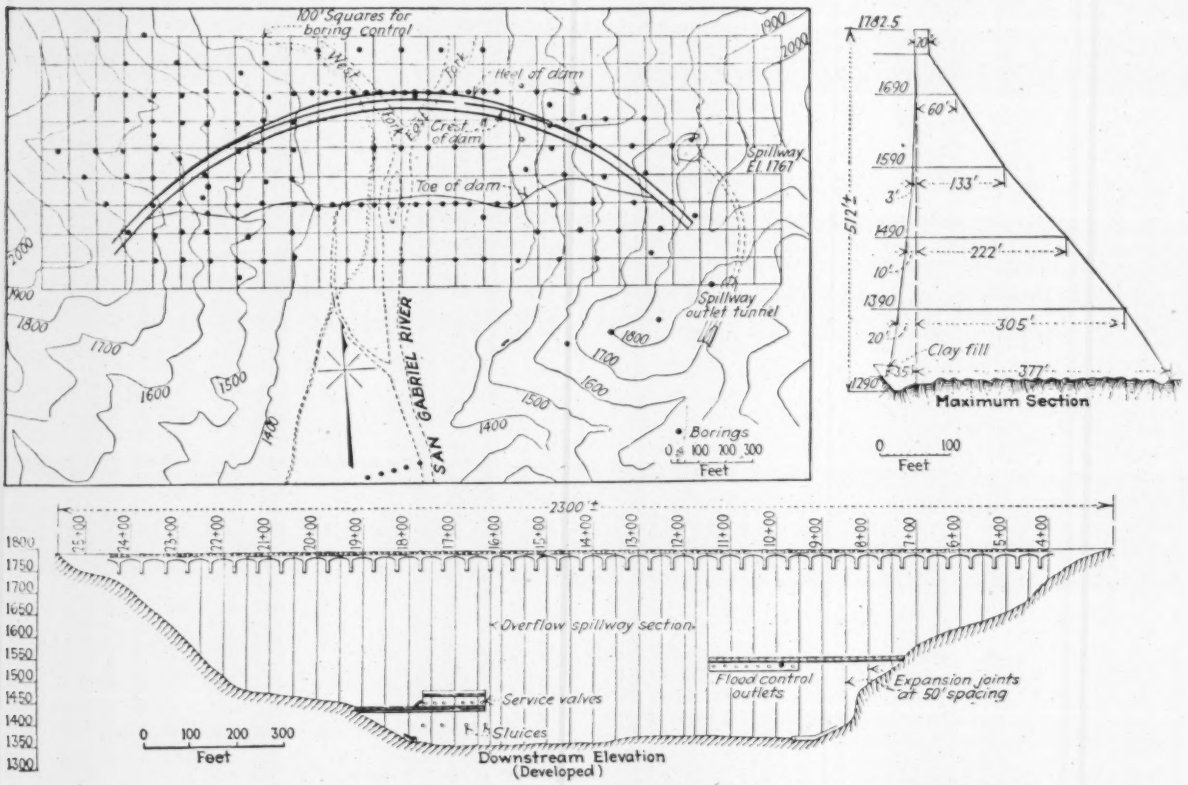
A shaft is now being sunk for exploration below the greatest depth called for in the plans for the San Gabriel dam. At the bottom of the shaft (Oct. 11, 1929) (approximately 110 ft. below the original ground surface) gouge-filled seams have been encountered, and gouge-lined fractures occur in the drift from which cross-cuts are to be run through the main fault zone. At the intersection of two of these fractures the gouge has been broken open and the openings have been filled with recently

deposited soft clayey material carried down from above by descending percolating water. This indicates extremely recent movement and attests to the open character of the fractured rocks.

North-South Faulting

A north-south joint or shear system dipping to the east and to the west occurs on both sides of the dam site. Gouge is sparingly developed.

On the west side the easterly dipping planes slope down hill at an average angle of 45 deg. The removal of the natural support of this block system into which the country rock has been cut by all the above-described systems of fractures caused the slide of Sept. 16, 1929, when approximately 200,000 cu.yd. moved toward and into the excavation. This movement was superficial, hence any sliding would not affect the rock foundation on which the structure would rest. However, sliding probably would cause serious difficulty during excavation and construction. As the dam is being constructed it would be necessary to restore the equilibrium of the slope, which has been undercut by the



GENERAL DRAWINGS OF SAN GABRIEL DAM FOR LOS ANGELES FLOOD PROTECTION

(Reproduced from *Engineering News-Record*, Nov. 15, 1928, p. 733.) Foundation rock at west abutment, at left in plan and elevation above, is found to be thoroughly fissured and crushed. A broad zone of faulted rock extends along the toe line of the dam and a sharply defined fault with evidence of recent movement is located near the line of the heel. The two intersect in the area of the west abutment. Extensive exploration by shafts and tunnels in this area shows the fracturing to continue to indefinite depth. Construction work has been in progress since early this year and already as much material has been removed from the side of the west abutment as the entire foundation excavation was expected to total. A rock slide occurred at the west abutment Sept. 16 (see *Engineering News-Record*, Sept. 26, p. 503.)

replacing of the material removed outside the structure so that no oversteepened slope is left.

Some evidence of ancient slides was noticed in the terraced slope of the two main ridges above the dam site. These slides probably occurred as the San Gabriel Canyon was being excavated by the river. Certain horizontal layers of crushed rock, such as is exposed in the north crosscut from W9, suggest ground-up material at the base of such slides. Foundation excavations must be carried below all such evidence of landslide movement.

Geological Conclusions

1. A dam of this size, the highest of the type ever built, must have sound bedrock of maximum strength.

2. The geological conditions of the east side are fairly satisfactory, although the belt of good rock between the faulted rocks on each side is only just wide enough to sustain the east abutment.

3. On the west side no satisfactory rock has as yet been encountered, with the possible exception of a few isolated exposures.

4. The intense shearing along the main fault zone, complicated by its intersection with the north side system of shear p[illegible]es, does not indicate probability of sound bedrock at reasonable d[illegible]ths.

5. The possibility of renewed movements along these f[illegible]lts and shears adds further hazard to the building of the dam.

6. Changes of load caused by filling the reservoir and w[illegible]ng of the complex system of fractures which cuts the bedrock [illegible]to block mosaic might cause slipping and adjustment between bl[illegible]ks.

Rock Unsuitable for Abutment Foundation

The contract plans indicate that the San Gabriel dam will [illegible]ve a height of about 500 ft. above foundation, but our inspectio[illegible] of the core borings, compared with the conditions already re-vealed by the excavations on the abutments, convinces us that it will be necessary to go considerably deeper than shown by the plans, so that the proposed dam would probably be over 50[illegible] ft. high, or about 150 ft. higher than the highest dam ever built. A dam of this great and unprecedented height requires an absolutely firm foundation.

Up to the time excavation was suspended at this point 385,000 cu.yd. of material had been removed from the west abutment. The average depth of the excavation is 40 ft. and the maximum depth about 105 ft. below the original surface.

Above El. 1,400, or about 40 ft. above streambed, below which elevation excavation has exposed what appears to be good rock over a part of the abutment, and below El. 1,730, above which there is a fairly good rock exposure, the sides of the excavation show a generally soft, crushed and weathered condition, with occasional blocks of hard rock embedded in the softer disintegrated or crushed material. This material is entirely unsuitable for the foundation of a high concrete dam.

The last mass shooting on this abutment was on July 11, 1929, since which time about 50,000 cu.yd. has been removed from the west abutment by steam shovel excavation, practically without shooting except that necessary to break up blocks too large for the dipper. That this soft and crushed condition of the rock was not the result of overshooting is shown by the fact that the steam shovel excavation has been carried 80 ft. beyond the nearest point of mass shooting.

All the indications of the exploratory shafts and tunnels, as well as of the dips and strikes of the main faults converging in this area, are that the disturbed and crushed conditions of the rock will extend to a great depth below and to a considerable distance beyond the bottom and face of the present excavation. In the above-described area of shearing and crushing, which covers a larger part of the foundation under the west abutment, there is only a remote possibility of reaching the firm hard bedrock required for the foundation of a concrete dam of the great height proposed.

The major east and west fault zone crosses the dam site in an approximately east and west direction, crossing the dam at an oblique angle under the downstream toe.

Condition of Bottom Questionable

About one-third of the dam rests, in part at least, on the crushed zone. Due to the greater compressibility of this zone the distribution of stresses in the dam would be far different from those which would occur with a uniform foundation. At every section crossing this zone the maximum stresses would be much higher than if the foundation were uniform, and at some sections where this zone approached the toe of the dam critically dangerous vertical fractures in the dam might result. In other sections where the downstream toe of the dam projects over the fault zone the dam would be subjected to stresses of the same character as would occur if the broken part of the foundation were to be completely removed. Both conditions would increase the tendency to overturn, besides greatly increasing the stresses already fully up to the allowable limit and probably would cause the dam to fail.

Conclusions

The diorite rock of which the foundation is composed when not crushed by faulting or weakened by weathering would form a suitable foundation.

At the east abutment the weathered rock has been removed and the hard unweathered diorite exposed. Such minor defects as exist in this abutment can probably be cured.

Excavation at the west abutment has been carried to much greater depth than originally expected, not only without reaching the sound unweathered diorite anticipated, but, together with the exploration tunnels and shafts, revealing conditions indicating that such sound rock would not be reached at any reasonable depth, if at all.

The fault exposures at the west abutment and a short distance downstream from the east abutment, together with the core borings beneath the streambed, strongly indicate a continuous fault zone under or near the downstream toe of the dam and nearly parallel to the axis. This is a most dangerous condition affecting the stability of the dam, especially when possible future movement along the fault line is admitted.

We are convinced by our study of all these conditions that a safe dam of the proposed height cannot be built at this site.

We recommend that further exploration and investigation be carried on to determine if a dam of less height can safely be built on the foundations obtainable at this site.

We also recommend that a study be made of other possible sites to provide such alternative or supplementary storage as may be required to give the necessary flood control and water conservation.

Action Taken

Steps to put into practice the recommendations of the report have already been initiated. The Los Angeles county supervisors on Oct. 25 appropriated $14,875 for the use of the state engineer in retaining, under the new dam control law, a board of engineers and geologists to report on the safety of the dam foundations. The supervisors are endeavoring to engage six engineers and geologists who previously reported on the Forks site, this group to make further investigation of the proposed site and dam height "in the light of newly discovered engineering data." In the meantime, the flood-control district is to make surveys of other possible dam sites on the San Gabriel or its branches.

Electrifying Italian State Railway Trunk Line

Italian engineers intend to have the Simplon tunnel fully electrified by next May. The Swiss are working on their side of the border and are also said to be making satisfactory progress.

Letters to the Editor

Standing Wave Flumes Again Compared With Venturi Meters

Sir—In reply to Clemens Herschel's letter in your issue of Sept. 12, I would explain that my opinions, which are now generally accepted in India, are not based on theory but have been proved by experience in all parts of India where irrigation is practiced on a large scale. To quote a specific instance: Concrete Venturi meters were constructed near the head of the Nira Right Bank canal to pass 1,750 sec.-ft., and half a mile downstream a standing wave flume was also constructed. Even with all charges except the concrete for the Venturis omitted, the Venturis still cost considerably more than double as much as did the flume. This was due not merely to the roof of the Venturi being costly but also to the necessity of making the roof low so as to be submerged when small discharges were flowing. This entailed either lowering the bed below canal bed level or constructing a battery of very wide, shallow Venturis. The former alternative was undesirable, as stony debris tended to deposit, while the latter increased the cost. A compromise was adopted, the bed being lowered some 2 ft. and the standing wave flume downstream designed so as to head up water below the Venturi in order to keep it submerged when small discharges were passing.

Concrete Venturi meters have also been designed by us for medium and small discharges and the results compared, but the result has always been the same.

Mr. Herschel's letter is headed "Hydraulic Jump Flumes Again." I must emphasize, however, that the Crump-type long-throated standing wave flume adopted in India discharges according to theory with an entirely negligible maximum error and is a very marked improvement on the Venturi flumes mentioned in *Engineering News-Record* of Sept. 2, 1920, and Bulletin 265 of the Colorado Experimental Station.

Mr. Burkitt has now used Mr. Crump's type of flume as a Venturi flume—that is, with subcritical velocities in the throat. This necessitates two readings and somewhat complicated calculations or tables but makes it possible to reduce the loss of head caused by the standing wave. Indeed, he shows that afflux can be entirely eliminated provided the gages are read with extreme accuracy. (See Paper 125, "Headless Canal Meters," by F. H. Burkitt, in the Punjab Engineering Congress *Proceedings* of 1929, Lahore, India.)

As regards the other points raised in Mr. Herschel's letter: (2) If the range were increased by a skillful compounding of several Venturi meters, as suggested, the cost would be increased enormously. (3) Practical experience shows the great advantage of the single reading, not merely on account of simplicity but also because the depression head (equal to one-third the upstream depth in a standing wave flume) is less in a Venturi flume and errors in reading have therefore a much greater relative effect. (4) The Venturi meter is purely a meter and hence does not deliver proportional supplies. A standing wave flume, on the other hand, is what is called in India a semi-module—that is, the upstream water level and the discharge are unaffected by a fall in the downstream water level; and when the sill is set correctly, varying between 0.1 and 0.2 times the upstream full supply depth according to the section of the channel upstream, a standing wave flume then delivers a supply which is the designed proportion of the flow in the parent channel.

Before closing I must reiterate my great admiration for the magnificent work carried out by Clemens Herschel, especially his Venturi meter for measuring water flowing in pipes. At the same time I must emphasize that for open channel work we have found in India that the Crump-type long-throated flume has very great advantages and it is rapidly coming into universal use. There seems to be no reason to suppose that it will be less successful in America.

London, England, C. C. INGLIS.
Sept. 25, 1929.

P.S. The paper quoted in my original letter published in *Engineering News-Record* of July 18, 1929 (Technical Paper

15 of the Bombay Public Works Department, "Notes on Standing Wave Flumes and Flume Meter Falls, by C. C. Inglis) is now out of print. A copy is understood to be available in the Engineering Societies Library, New York.

New York's Multiple Dwelling Law

Sir—I noticed in the Oct. 3 issue of *Engineering News-Record*, on p. 519, that you refer to the architects' and engineers' position as a result of the reversal by the Court of Appeals of the multiple dwelling law. For your information I would state that the decision had nothing to do with the question of the architects and engineers. That matter was not discussed by the court, because the question before it was whether the multiple dwelling law was passed in accordance with the Constitution of the state. The individual parts of the law were not questioned.

The New York State Society of Professional Engineers and Land Surveyors, of whose metropolitan conference committee I am chairman, composed of the various counties in and about the city of New York, has brought the Goldschlag case before the courts, and Judge Mullen has not yet decided that issue. The issue raised in that court was whether section 300, which you speak about in your magazine, was constitutional. When the decision of Judge Mullen is handed down, the engineers and architects will know where they stand on this multiple dwelling law.

It is the purpose of the New York State Society of Professional Engineers and Land Surveyors, through its metropolitan conference committee, if Judge Mullen decides against the engineers, to take the question into the federal courts on the ground of violation of the Constitution of the United States. The legal aspect of this case is being handled by Joseph Sterling, Assistant Attorney-General of the United States during the administration of President Wilson.

So let's not give up hope merely because the entire law was declared constitutional on the theory of its having been passed legally. The outcome of the Goldschlag case will settle the problem. DAVID M. OLRARSH.

New York, N. Y.
Oct. 4, 1929.

The reversal by the state Court of Appeals of the decision of the lower court declaring the whole multiple dwelling law unconstitutional because of the way in which it was passed by the legislature again put that law into effect. In so doing it opened up the question of the constitutionality of individual sections of the law, a question which had been closed when the whole law was declared unconstitutional by the lower court. A case to test the constitutionality of section 300, which does not permit licensed professional engineers to file plans for multiple dwellings, had been started before the law was declared unconstitutional. That case, as Mr. Oltarsh points out, is now before Judge Mullen. Our comment was not upon the constitutionality of that section.—EDITOR.

Good Service From Pipe Joints Under Trying Conditions

Sir—In your issue of Sept. 12 you carried an article by A. Palotan, assistant engineer of water supply, Jerusalem, Palestine, concerning difficulties encountered on the Jerusalem pipe lines because of the extreme variations in temperature that prevail there. Although Mr. Palotan was good enough to bring out in his concluding paragraph his successful and satisfactory experience with Victaulic joints on that line, there was in his article a passing reference to the action of these joints that might be otherwise construed by a hasty reader.

In connection with this and to confirm further the author's comment on the satisfactory service given by these joints in this exacting service over a period of three years, I thought it would be pertinent to get on record the fact that the line in question survived the earthquake of 1927 without the slightest injury. A. Kock, water engineer for Jerusalem, then reported as follows:

"Fortunately no defects whatever occurred to the pipe line. At the lowest section of the line, which is laid on a very steep slope (20 per cent), one of the anchoring concrete blocks has burst due to the longitudinal movement (about 3 or 4 in.) of the main, but no leak or burst whatever occurred to the pipes or joints, which remained perfectly intact.

"For your further information I may add that since the installation of this water main (July, 1926), in spite of the practically uninterrupted pumping operations up to date and of the rather high pressure (280 lb. per sq.in.) at certain sections of the line, which is laid practically free on the surface of the ground, no leakages or bursts have occurred."

W. B. DAMSEL,
Vice-President, Victaulic Company of America
New York, N. Y.,
Oct. 22, 1929.

The Cairo Flood Problem

Sir—As an engineer who has been fortunate enough to have been allowed to devote some time to the exclusive study of flood-protection problems, may I be permitted to agree with the doubts expressed in your article in *Engineering News-Record*, May 23, 1929, p. 815, as to the wisdom of the measures which are apparently being adopted to afford protection to the city of Cairo from Mississippi floods?

Flood protection at first sight appears to be quite simple. Erect levees, or "bunds" as we call them here, and floods are excluded. The problem is, however, very much more difficult than that, because it can safely be said that in 99 cases out of 100 the effect of controlling a river by levees is at once to raise the possible high-flood stage in the river, and the difficulty is to calculate this rise.

The Cairo problem seems to combine these two ideas. The city is first protected by levees, and then to protect the levees an effort is made to lower the possible high-flood crest of the river. This is, of course, perfectly sound if it can be done, but I venture to suggest that the method by which it is proposed to lower the flood crest is open to criticism.

From the diagrams in your article it appears that it is intended to allow the river have its own way below Cairo, and it is probable that the fuse-plug levees, or "breaching sections" as we should call them, are the only solution of the problem. This will certainly keep the river under reasonable control below Cairo, but how will this affect the levels at Cairo itself? Your engineers reply that the back-water curve will extend well beyond Cairo, and that therefore Cairo will be benefited.

Is this not a curious way of obtaining the desired result, even if it should happen to be successful? The flood crest well below Cairo is to be lowered by allowing a broad flood channel and improving the value of n by clearing, and then the extremely dubious and difficult-to-calculate back-water curve is relied upon to protect Cairo itself.

Of course, I am not in possession of any of the data at the disposal of your engineers, but I would most certainly like to inquire why the problem cannot be attacked directly by lowering the flood crest opposite Cairo itself. This could only be done by providing a broad flood channel on the right bank of the river, and the obvious position for this channel would appear to be from the bend northeast of Charleston to somewhere in the neighborhood of Belmont.

I do not doubt that this would be an extremely costly operation, and I notice that there are at least two railway embankments to cross. However, according to your diagrams, this area was flooded in 1913, and from the contours it would appear that the problem is not beyond the range of possibility. My impression of American engineers is that if they want to move a mountain they will do so, and I do not imagine that a few hills, railway embankments or buildings would worry them much.

The science of flood protection is still in its infancy, and for the benefit of engineers in other parts of the world who are studying its problems it is to be most sincerely hoped that through the medium of your valuable paper American engineers will broadcast as much as possible their experience, calculations and methods employed in dealing with this most interesting and important subject.

C. E. HILLMAN,
Divisional Irrigation Engineer,
Southern Division, Colombo Flood Protection.
Tangalla, Ceylon,
Sept. 5, 1929.

News of the Week

Water Supply Causes Typhoid Epidemic in Wisconsin

Twenty cases of typhoid fever and over 1,000 cases of dysentery have been reported in Fond du Lac, Wis., as the result of a polluted water supply. Recent river straightening operations damaged the casing of an old private well, according to L. F. Warwick, state sanitary engineer of Wisconsin, permitting water from the Fond du Lac River to enter the city groundwater supply. A definite connection was established by tests with a salt solution. The city water supply is now being chlorinated and the defective well is being sealed with cement.

Contract for Seattle Water Pipe Is Rescinded

Hans Pederson, Seattle (Wash.) contractor, who on a bid of $780,419.30 secured the contract for the construction of the wood pipe portion of the Seattle city water department Lake Youngs aqueduct, has been relieved of his contract by vote of the board of public works. Pederson said he could not obtain the necessary materials in time to fulfill his agreement. A new call for bids on wood stave, steel and concrete pipe will be issued soon. When the bids were opened for the contract that has just been rescinded, there was but one other bid besides Pederson's, made by the Federal Tank & Pipe Company, $918,417.70.

Contract Awarded for Dam and Power House at Safe Harbor, Pa.

The Arundel Corporation, of Baltimore, has obtained the contract to construct the dam and power house for the new hydro-electric development at Safe Harbor, Pa., by the Safe Harbor Water Power Corporation. The development calls for an investment of $30,000,000. As stated in *Engineering News-Record*, Oct. 24, 1929, p. 671, the dam will be 3,625 ft. long.

Duluth Bridge Span Lifted

On Oct. 20 the 410-ton overhead truss of the Duluth ferry bridge across the entrance to Duluth harbor was successfully hoisted 41 ft. as part of the work of converting the old ferry bridge to a lift bridge. The hoisting was completed in 42 minutes by means of two 200-ton counterbalance weights. Cables from the weights passed over four large wheels at the top of the two towers and were connected to the lower chords of the overhead truss. Plans for the conversion of the bridge were described in *Engineering News-Record*, Dec. 27, 1928, p. 962.

Relief Measures for New York City Traffic Outlined in Report

Improvements and New Construction Aggregating $1,000,000,000 Included in Plan

RESULTS of a comprehensive survey and analysis of vehicular traffic conditions in the city of New York and a program of procedure for traffic relief have been transmitted to the city authorities by Day & Zimmermann, Inc., consulting engineers. To relieve the situation, the report recommends ultimate new construction and improvements to existing facilities aggregating $1,000,000,000 in cost, although a portion of this expenditure can logically be deferred until some time in the future. The present congestion, it is stated, is unusually severe because the activities of the entire metropolitan area, with a population of more than 10,000,000, are centered in a relatively small area in the lower end of Manhattan Island. Scattered throughout the five boroughs are areas of varying sizes in which business has centered and in which local congestion has developed. This is usually aggravated by through traffic which might well use other and more direct routes were they available. The report states that during the last twenty years the number of vehicles crossing the East River daily has increased from about 15,000 to nearly 200,000, yet no additional crossings have been provided. This tremendous volume of traffic, concentrated chiefly on the four existing bridges, creates conditions at the bridgeheads and elsewhere in the lower section of the city which are rapidly approaching unmanageable proportions from the standpoint of regulation.

General Plan of Relief

Possible relief measures fall under four general groups, according to the report. These are classified as follows: (1) Development of the city and its activities along lines that will tend to reduce street traffic and particularly concentration in specific areas. (2) Intensive utilization of existing streets, bridges and other facilities. (3) Improvements and extensions to existing facilities. (4) New construction.

The general subject of city planning, included in the first classification, is not taken up in the present report, as it is being thoroughly considered by other agencies. More intensive utilization of present facilities is largely a problem of regulation, which is exceedingly difficult at points where present facilities are being utilized far in excess of their efficient capacity. While some improvement is possible by means of more rigid parking regulations, pedestrian control and other measures, practically the many diverse interests to be reconciled make progress extremely slow. Therefore, in the opinion of the consultants, practical measures must be confined largely to improving existing facilities and the creation of new traffic arteries. Circulation of traffic can be improved in a very practical way by roadway widening, the removal of obstructions, minor extensions, better paving and similar means, the cumulative effect of which will bring

BUILDING THE HIGHEST SUSPENSION BRIDGE

Wide World Photo

Near Canyon City, Colo., a suspension bridge is being erected which is said to be the highest in the world, as the roadway will be approximately 1,050 ft. above the streambed at the foot of the canyon. It will span the Royal Gorge with a main span of 880 ft. and a total length of 1,200 ft.

substantial relief. A large number of such projects are described and recommended in the report.

Recommended Construction

Intensive building developments in the congested districts render the opening of new streets impossible because of the prohibitive expense involved. The same objection applies to extensive grade separation at congested intersections. It is believed that the best results can be accomplished by providing facilities which will divert traffic now passing through congested areas and by providing direct routes of entrance and exit from these areas. Suggested improvements include additional interborough connections, in connection with distributing and collecting highway systems, and marginal and other through highways of large capacity free from cross-traffic. A large number of such improvements are recommended in the report, among the more important of which are the following: the Triborough bridge (construction already started); the 38th St. tunnel, (already approved); a tunnel from the lower end of Manhattan Island to Brooklyn; a tunnel connecting Brooklyn and Staten Island under the Narrows of New York harbor; a north-south vehicular tunnel extending the length of Manhattan, probably under Fifth Ave. (for construction in the future); marginal highways along both waterfronts of Manhattan Island (one of these is already under construction); an arterial highway across Staten Island; and a number of through highways in Brooklyn, Queens and the Bronx.

Two Power Licenses Granted

A license for the Inland Power & Light Company, of Portland, Ore., was authorized by the Federal Power Commission at its meeting Oct. 16. The authorization follows compliance with a preliminary permit covering the development of power on the Lewis River. The proposed license is to cover the Ariel site, where it is planned to install 54,000 hp. The ultimate installation will be 216,000 hp. Prelicense costs have not been agreed upon, but the commission waived the provisions of order No. 27 in this instance so that construction work could begin this fall.

A license also was authorized for the Washington Electric Company, of Seattle. The authorization covers a project on the Columbia River near Wenatchee. The initial installation is to be 84,000 hp., with the subsequent addition of 210,000 hp. The license is to contain a condition that the commission's findings with regard to prelicense costs are to be accepted. The Chief of Engineers in reporting on this project stated that it will fit into any comprehensive scheme for the improvement of the Columbia River for navigation, that it will not interfere with proposed plans for irrigation, that its construction will aid in the development of adjacent arid regions and that the navigability of the river will be improved.

Work Is Started on Beauharnois Power Canal

The formal inauguration of work on the Beauharnois Power Canal took place recently when Lord Willingdon, Governor-General of Canada, turned the switch that caused the first blast at the site of the power house, near Beauharnois. The canal will furnish the first step toward the development of the St. Lawrence deep waterways project. It has been undertaken by the Beauharnois Power Company, a subsidiary of the Beauharnois Light, Heat & Power Company, and involves the construction of a 3,000-ft. navigable canal which will ultimately have a depth of 30 ft. The first objective is the development of 500,000 hp., of which 200,000 hp. is expected to be ready by October, 1932. It is proposed ultimately to increase this to 2,000,000 hp. when the whole river will be diverted through the canal. According to a statement by President R. O. Sweezey, a cross-section of 90,000 ft. will be provided by the canal with water flowing through at the rate of $1\frac{3}{4}$ miles per hour. It is estimated that the work will require the removal of from 10,000,000 to 12,000,000 cu.yd. of earth and stone.

Lake Storms Damage Chicago and Sink Car-Ferry

Severe storms on Lake Michigan last week caused extensive damage along the entire frontage of Chicago. Beaches and shore protection works were destroyed, parks were flooded and scoured and much damage was done to the paving of drives, while in some cases sand and mud were deposited on the parks and roadways. Private property also suffered by damage to buildings and erosion of the shore line by the heavy waves. Rough estimates indicate that nearly $1,000,000 will have to be spent for repair and protection work. New breakwaters are suggested for shore protection, while the Lincoln Park Commission has plans for a series of jetties about 200 ft. long and 200 ft. apart to prevent the erosion of beaches.

The car-ferry steamer "Milwaukee" of the Grand Trunk Railway was lost with all on board, Oct. 9, 1929, in the storm. It is supposed that on the voyage from Milwaukee to Grand Haven some of the 27 cars broke loose and caused the boat to list, allowing the heavy waves to break in over the stern, which is open to allow cars to be run in and out. Elsewhere the boat had a high freeboard, but except for a bulwark which was placed around the stern after the cars are on board, this part of the ship was open above the car deck. The "Milwaukee," 338 ft. long, with four tracks, was built in 1903 and had been overhauled recently. More than 50 men were aboard. A similar ship of the Pere Marquette Railway was lost in 1910 and the same cause was suggested, although nobody lived to tell what happened.

During the storm a section of the Milwaukee breakwater 800 ft. in length was washed away. As two types of construction are used in the breakwater, army engineers believe that the stresses caused by this storm with the resulting damage will afford an interesting basis of comparison. The northern section of the breakwater consists of a substructure of timber cribs with a concrete superstructure. The southern section is of all-concrete construction. It was in the southern end of the structure that the break occurred. While no report on the damage has been made, it is believed that the break was chiefly due to the lack of adequate riprap protection. On the west side of Lake Michigan foundation conditions in the harbors are poor because of the presence of large amounts of soft sand. It is believed that the timber-cribbed substructure may be found to hold up better under these conditions pending the completion of riprap work.

New Bridge Planned Across Savannah River

A recent conference between the state highway commissions of South Carolina and Georgia insures future protection of interstate highway traffic from floodwaters by the building of an all-weather bridge near Augusta, Ga., across the Savannah River, which divides the two states.

Engineers of the two state highway commissions have been instructed to draw proposals for such a structure to be submitted for joint approval by the city council of Augusta, the Richmond County (Ga.) road authorities and the highway commissions of the two states. The cost of the bridge, which has not been estimated, will be divided as follows: 50 per cent to be borne by the city of Augusta, county seat of Richmond County, and 25 per cent each by the Georgia and South Carolina highway commissions. Should federal aid be secured for the project, these proportions will be subject to change.

The two state commissions also announce that $150,000 will be spent on repairs to the Sand Bar ferry bridge, which spans the Savannah 2 miles below Augusta. This was damaged by the recent floods.

North Dakota Water and Sewerage Engineers Organize

A conference of water and sewerage engineers of North Dakota was held Oct. 16 and 17 in Bismarck, called by A. L. Bavone, state engineer, attended by about 30 municipal water and sewerage superintendents and members of their staffs. Several papers were read and discussions made on many of the state's problems. Permanent organization was effected by the election of E. J. Thomas, of Minot, president; William Yegen, of Bismarck, vice-president; and A. L. Bavone, secretary. During the ensuing year steps will be taken to increase the membership and thus obtain membership in the American Water Works association.

Brief News

EXACTLY ON SCHEDULE, the final girder in the new 33-story 120 Wall St. Building, New York City, has been set. The 8,000 tons of steel used in the structure was erected in ten weeks.

THE FIRST HOPPER OF CONCRETE was poured into the spillway structures at Bonnet Carré on Oct. 22.

THE CAIRO BRIDGE over the Mississippi River between Cairo, Ill., and the Missouri side of the river has been opened, the Governors of Illinois and Missouri taking part in the ceremony.

A GEORGIA WATERWAYS AND FLOOD COMMISSION is proposed in a resolution adopted by the legisluature of the state, memorializing Congress to pass appropriate legislation.

THE LARGEST CONCRETE BUILDING in the world, as well as the largest single building in the British Empire, is planned in London, to be known as the Olympia and to be used for exposition purposes. Its main facade will be 330 ft. long. The building will have four floors, each capable of holding 3,600 persons. There will be 250,000 sq.ft. of floor space.

THE FLYING FIELD at Rockland, Me., hitherto privately owned, has been purchased by the Curtiss Flying Service. More than $100,000 will be spent in transforming it into a Class A airport, and it will be made the northern base of the Curtiss company.

STEEL PIPE will be used for the penstocks of the high-head hydro-electric plant soon to be opened in Vorarlberg, Austria. To withstand the head of 1,400 meters (4,600 ft.) steel pipe of 75-mm. thickness will be used, reinforced by rings with a spacing of 5 in.

CITY MANAGER government will be legal in Michigan City, Ind., until the councilmen to be elected Nov. 5 take office on Jan. 1, is the ruling of the state Attorney-General. Michigan City is the only municipality in the state governed by a city manager. The state law authorizing the system was declared unconstitutional Sept. 24, as noted in *Engineering News-Record*, Oct. 3, 1929, p. 545.

TWO LINES OF RAILWAYS in the Gaspé peninsula, Canada, the Quebec & Occidental and the Quebec & Western, have been acquired by the Canadian National Railways, for about $3,500,000. They serve a population of 60,000.

A NEW SAFETY RECORD for the company is reported by the American Rolling Mill Company, Middletown, Ohio. The entire personnel of more than 11,000 worked without a lost-time accident for the first ten days in October. Previously nine days without a lost-time accident was the record.

WIRE ROPE is being investigated by the German Institute of Steel Construction, with special reference to its use in suspension bridges. Use of this material for bridge cable, never very common in Europe, has been adversely affected by the trouble experienced at the Mount Hope and Detroit suspension bridges in the United States.

DEDICATION OF THE BAY SHORE HIGHWAY took place officially Oct. 20, following the completion of the final portion of the new thoroughfare, which extends between San Francisco and San Mateo, Calif. An article covering this highway appeared in *Engineering News-Record*, Jan 31, 1929, p. 168.

BERLIN'S WATER SUPPLY is being increased by a $5,000,000 supplementary plant which is to supply 40,000,000 cu.ft. per day. For use in the plant two American filtration patents have been purchased and two American engineers have been engaged to supervise the installation of the filters.

DUMPING OF GARBAGE in the Atlantic Ocean by New York City to the detriment of New Jersey shore residents will be investigated by Edward K. Campbell, appointed a special master for that purpose by the U. S. Supreme Court. Mr. Campbell, who was formerly chief justice of the Alabama Court of Claims, will take testimony and make recommendations.

A HYDRO-ELECTRIC PLANT is planned by subsidiaries of the Carbide & Chemican Corporation for the manufacture of ferrochrome. The plant will cost more than $50,000,000. The power house, tunnel and dam will be located on the New River in Virginia. The dam will be 900 ft. long, and the tunnel 16,250 ft. long, with a diameter of 28 ft. Four 35,000-hp. generating units will be installed.

RECOMMENDATION TO WITHHOLD granting a permit and approval of plans for the erection of a bridge across the Ohio River at Carrolton, Ky., has been made to the War Department by three United States district engineers who conducted a hearing. A report submitted by the engineers states that the permit should be withheld until such time as it can be shown that the needs of the locality for the bridge outweigh the hazard to navigation.

DEDICATE PARDEE DAM IN CALIFORNIA

Completion of the Pardee dam, of the East Bay Municipal Utility District, on the Mokelumne River in California was celebrated Oct. 19 with dedication ceremonies. The structure is 358 ft. high above streambed, has a crest length of 1,337 ft. and contains 615,000 cu.yd. of concrete. Construction occupied 24 months, during which a concrete placing record of 67,565 cu.yd. in one month was made. The separate spillway structure appears in the background of the illustration. Concrete aggregates were brought to the job by a 4-mile aerial tramway.

St. Paul Votes on Council-Manager Plan Nov. 5

On Nov. 5 a popular vote will be taken at St. Paul, Minn., on displacing the existing commission plan city charter by a council-manager charter. For some years the city has been governed by a mayor and six commissioners in whom were vested all legislative and administrative functions. Under the proposed charter there would be a council of eleven members, including the mayor, all elected at large, and a manager, appointed by the council.

While in the main the charter runs true to council-manager form, there are some notable variations. Among these are some overlapping powers of the mayor and the other commissioners, including veto power of ordinances and appropriations by the mayor, subject to passage over his veto by eight of the ten councilmen, and approval by the council of some appointments made by the mayor. The manager would make most but not all appointments of department heads, and at his own option might head any one or all of four important departments: finance, works, safety and parks, playgrounds and recreation. The water-works would be administered by a board consisting of the mayor, as chairman, the city manager, and a member of the council who would be chosen by the council.

The mayor would appoint a board of education of seven members and a city planning commission of nine members, the latter subject to approval by the council. The civil service commission of three members would be composed of the city manager, a representative of the classified service of the city appointed by the mayor without competitive examination, and a member appointed by the council.

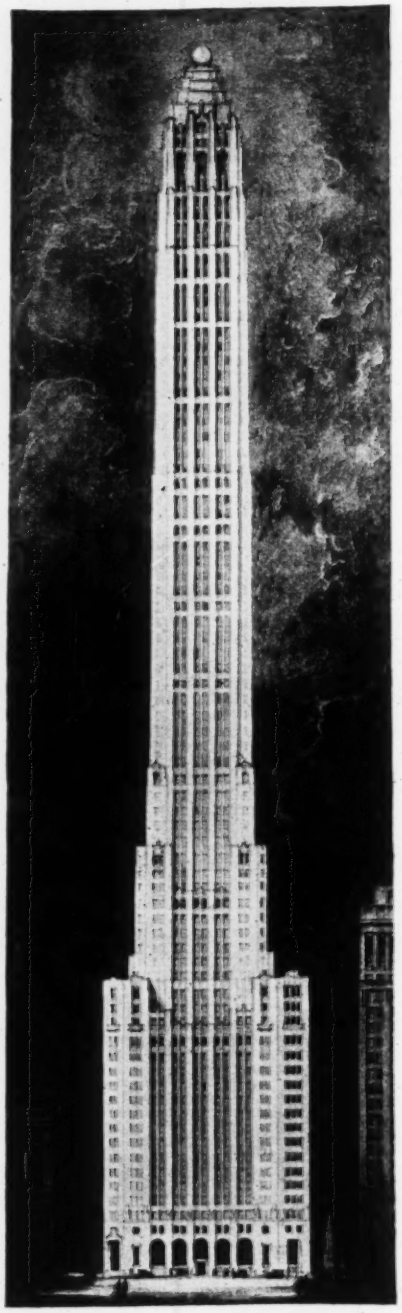
To carry, the proposed charter must receive 60 per cent of the votes cast on Nov. 5. It would go into full effect June 30, 1930. The population of St. Paul was 234,698, according to the census of 1920.

British Columbia Pulp and Paper Plant to Expand

The Powell River Company, of British Columbia, will spend $6,000,000 to $8,000,000 on hydro-electric development on Lois River and the installation of another paper-making machine to use the extra power thus provided. The pulp and paper company was given assurance by the provincial government water board that its application for development rights on Lois River were granted, and formal permission will be issued shortly.

At present the Powell River pulp and paper plant uses approximately 50,000 hp. generated from the fall of water from Powell Lakes to the sea. The company plans to add a plant on Lois River, 10 miles distant, which will give an additional 32,000 hp. About half of this capacity is to be developed within the next year or so.

TO ERECT 925-FT. BUILDING



Plans have been completed by the City Bank-Farmers Trust Company for a 925-ft. office building to be erected in the financial district of New York City. This will contain 71 stories and four basements, a total of 600,000 sq.ft. of office space, and will be faced with Alabama limestone. Clearing of the site has already been completed, foundation work is scheduled for completion Feb. 1, 1930, and the building is expected to be ready for occupancy Jan. 1, 1931. George A. Fuller Company, Inc., is the contractor; Cross & Cross are the architects.

Work Begun on San Francisco Air Terminals

The Curtiss-Airports Company now has under construction on San Francisco Bay two large air terminals, a transport field on the east side of the bay in Alameda and an industrial field in San Mateo County, just south of the San Mateo city boundary. About $7,000,000 is to be expended on these two developments. Both locations will be used for commercial flying, and the San Mateo port, which covers an area of 480 acres, also will have a separate division for a flying school, an airplane assembly plant and a department for the complete servicing of Curtiss-Wright products. Because portions of both fields are at present in service on a temporary basis, several of the departments are now operating, although development of the fields cannot be completed for several months. Work is under the supervision of Frank M. Bartlett, general manager for the Curtiss Flying Service in northern California.

Cable Work Begun on Hudson River Bridge

On Oct. 18 the first wires of the cables for the 3,500-ft. Hudson River suspension bridge at New York City were strung in place. Stringing has continued since then and will go on without intermission for the year or more required to complete the four cables. On Oct. 28 about 1,000 wires were in place in eight strands. The contractor, the John A. Roebling's Sons Company, of Trenton, N. J., is using stringing plant which departs radically from that used on prior suspension bridges, with a view to attaining the great speed of work necessary to complete the cables by the end of 1930.

Four cables of 36-in. finished diameter are being constructed simultaneously. Two cables are located on each side of the roadway, the two of a pair being as close together as the saddle construction permits. One wire rope tramway serves each cable, and as there is a traveling sheave on each rope and two wires are placed by a sheave at each transit, a total of sixteen wires is placed at once. The tramways operate at speeds of 600 to 700 ft. per minute, which is considerably greater than speeds previously used. Because of the high speed, the wire reels at the anchorages are positively driven. Between reel and outgoing line the wire passes over a weighted sheave which maintains a constant wire tension of about 200 lb. The reel-drive operator, by watching the position of the weighted sheave, is able to keep in time with the movement of the stringing sheave across the span, so that trouble from slack wire is avoided. For adjustment of the wires, signaling along the span is done by electric lamps controlled by push-buttons at the points of adjustment check. To pull the wires for adjustment, motor-operated comealongs are

used at anchorages and tower tops, replacing the handwork of former stringing operations in view of the large wire tension (about 500 lb.).

At each anchorage the working platform for the men at the strand shoes is a steel structure arranged to travel on an inclined track laid parallel to the face of the array of strand shoes, so that as work proceeds from the tower strands upward the platform can be quickly shifted to position for work on the next tier above.

Welded steel reels, steel footbridge framing, steel sheave-support frames, and tension frames and take-up tackle for the tramway ropes are other items of the stringing plant. On each tower top there is a 150-ton traveling crane, operating on a runway over the saddles, to transfer the finished strands from their stringing supports to final position in the saddles.

The work is in charge of C. C. Sunderland, chief engineer of the John A. Roebling's Sons Company, with W. E. Joyce resident engineer and Charles M. Jones assistant resident engineer. It is supervised for the Port of New York Authority by M. B. Case, engineer of construction, and Homer R. Seely, resident engineer.

Rehearing on Valuation Denied to California Company

The California Railroad Commission has denied the petition of the Great Western Power Company of California for a rehearing on the commission's order fixing just compensation to be paid by the city of San Francisco for those portions of the company's electric distributing system in San Francisco which the city proposes to acquire for a distributing system for Hetch Hetchy power. In its order the commission fixed the valuation of those properties as of Feb. 11, 1924, at $11,815,000, compensation for the properties and the business incident thereto having been set at $8,470,000 and severance damages at $3,375,000. The company had evaluated the properties and business at $30,000,000, with $15,000,000 for severance damages.

New Steel-Fabricating Plant for British Columbia

A contract for construction of the first unit of the Dominion Bridge Company's steel-fabricating plant at Burnaby, B. C., being erected to serve the growing structural steel requirements of the province, has been awarded to the E. J. Ryan Contractors Company, Ltd., for $1,500,000. It is understood the bridge company plans ultimately to spend $5,000,000 on this undertaking. Work on the 38-acre site will start immediately. Several buildings of steel and reinforced-concrete construction will be included in the first unit. The municipality of Burnaby has agreed to install a 12-in. water main and also, in conjunction with the city of Vancouver, to construct a 20-ft. concrete highway.

$50,000,000 Six-Year Power Program in British Columbia

The annual report of the British Columbia Power Corporation, issued Oct. 15, presages an expenditure of $50,000,000 on power development within the next six years. The money will be spent largely on development of Bridge River, Ruskin and Campbell River hydro-electric projects. The total capacity of Bridge River is estimated in the report as 750,000 hp. Development of the tunnel connecting Bridge River with Seton Lake is proceeding steadily, being 70 per cent completed, the report states.

In the Ruskin development the ultimate capacity is reckoned at 188,000 hp. and will cost $20,000,000. About 47,000 hp. will be brought into service in about a year.

The Business Outlook

Business is holding somewhat steadier. Industrial and trade conditions are much more stable on the record than they are in conversation. The rumors, statements and opinions that are rushing a worried market up and down from day to day tell us a lot about the market, but are of absolutely no significance as regards the business situation. But it is doubtful whether any reduction in the Federal Reserve discount rate can be ventured under present conditions without inviting another spell of speculation.

The general average of operations in the steel industry is a shade higher for the week (80 per cent), due to a slight increase in the Steel Corporation's activity, generally explained by the sustained level of railroad demand. Rail buying appears to be slightly above the normal rate for this time of the year, and equipment orders are maintaining the peak level reached in May. Structural steel orders rose sharply for the week. Automobile demand is at a low level.

—The Business Week, Oct. 26

Highway Officials to Meet at San Antonio in November

Only a few formal papers will be presented at the fifteenth annual meeting of the American Association of State Highway Officials to be held Nov. 12-15 at San Antonio, Tex. These include the following to be presented at general sessions of the convention: "Low-Cost Surfacing and Maintenance," by T. H. Cutler, chief engineer, Missouri State Highway Commission; "Financing Highways," by Thomas H. MacDonald, chief of the U. S. Bureau of Public Roads; "Parks and Highway Beautification," by G. C. Dillman, State Highway Commissioner, Michigan; "Prequalification of Bidders," by P. M. Tebbs, assistant chief engineer, Pennsylvania Highway Department; and "Detours and Maintenance of Traffic Control," by H. G. Shirley, State Highway Commissioner, Virginia.

Informal open discussions on many topics of interest to roadbuilders will be held at group meetings devoted to the following subjects: administrative problems; road design; bridge design, construction and maintenance; road construction problems; maintenance and traffic control; materials and research; accounting; and road equipment problems.

The remainder of the formal program will consist of reports by standing committees and sub-committees and the usual business session of the association. In addition, a number of interesting social events are scheduled.

Roadbuilders Hold Airport Conference in Washington

The municipal airport conference held in Washington Oct. 24 and 25 under the auspices of the City Officials' Division of the American Road Builders Association and the Aeronautical Chamber of Commerce of America was attended by more than 200 city engineers, contractors and men in the aeronautics industry. Nearly every phase of airport activity was considered. Outstanding papers on the program from the point of view of the man charged directly with airport construction were "Airport Drainage," by C. A. Hogentogler and F. A. Robeson, of the Bureau of Public Roads, and "Airport Surfaces," by C. N. Conner, engineering executive, American Road Builders Association. Abstracts of these papers will be published in an early issue of this journal.

In a paper "Airport Planning," B. Russell Shaw, an airport engineer of St. Louis, gave a general review of the airport situation. Mr. Shaw pointed out that aircraft designers are replacing tail skids with tail wheels, that in many cases both landing and take-off runways are advisable, that illuminating the roofs of hangars gives the pilots a degree of depth assisting materially in finding the surface of the field when leveling off and that public accommodations, including adequate highways leading to the airport and adequate parking spaces around the airport, should be provided.

Kenneth Franzheim, of the Curtiss Airport Corporation, ventured the opinion that no airport building of today will be standing five years from now. At the same time he made a plea for planning all airport developments so as to create a harmonious group of structures of permanent character. According to Mr. Franzheim, "a number of theories have been advanced on the general practice of laying out an airport, but in working on twenty or more of them to date we have yet to find a single theory that does not evaporate in the face of practical field problems." He pointed out that, in addition to hangars, buildings are required for overhaul and repair bases, for dope and paint shops and

for motor test purposes. The dope and paint shops should not be located nearer than 150 ft. from any other building and a special fire protection and ventilation system should be incorporated into their design.

In a paper entitled "Airports and Public Parks," Lieut.-Col. U. S. Grant, director of public buildings and parks of the District of Columbia, pointed out how the previous training of city park departments fits them to handle municipal airports economically and efficiently. Clarence M. Young, Assistant Secretary of Commerce for Aeronautics, in an interesting address, reviewed his experiences in flying his own plane through Europe. "Despite the handicap of numerous near-by international borders, air commerce in Europe is growing rapidly," according to Mr. Young. Some of the other facts brought out in his address were that the three outstanding airports in Europe, Croydon at London, Le Bourget at Paris and Tempelhof at Berlin, are approximately 400 acres in area. Croydon is 45 minutes to an hour from downtown London, Le Bourget is about the same from Paris, while Tempelhof is only fifteen minutes from the business section of Berlin. The latter is perhaps the outstanding airport of Europe, largely by reason of its accessibility. The long distances from the airports to the business districts of American cities was also scored by David S. Ingalls, Assistant Secretary of the Navy for Aeronautics. E. P. Goodrich, who has just returned from China, where he played an important part in selecting a site for an airport in Nanking, stated that this particular airport will be located in the heart of the city. Mr. Goodrich pointed out that the location of airports at such points requires a very careful study and routing of city traffic both to the airport and either through or around it.

2,400-Ft. Dam Project in Quebec

Excavation for a dam on the Mattawin River at Toro Rapids, near St. Michel des Saints, Quebec, will soon be started by the Shawinigan Engineering Company, a subsidiary of the Shawinigan Water & Power Company, in order to regulate the water so that a greater minimum flow may be made available for the power works farther down the river. The dam will be about 2,400 ft. long and will include an earth section 1,830 ft. in length having reinforced-concrete walls at the channel and a concrete section 570 ft. long. This concrete section will include regulating sluices, discharge sluices and a small hydro-electric unit for the operation of the dam.

The water level at the dam site will be raised between 60 and 65 ft. and will flood considerable territory between the dam and St. Michel des Saints. It is estimated that the capacity of the impounded water will be 36 billion cubic feet.

New School of City Planning at Harvard

Prof. Henry Vincent Hubbard, of the faculty of landscape architecture, has been named as the first incumbent of the new Charles D. Norton chair of regional planning at Harvard, and will direct the school of city planning. Simultaneously with Professor Hubbard's election the Harvard Corporation voted the establishment of the school and the establishment of the degree of Master in City Planning.

H. V. HUBBARD

Preliminary plans for the location at Harvard of the first school of city planning ever opened in this country were made public in September. At that time it was announced that a chair had been founded by the gift of James P. Curtis, of New York City, but that no incumbent had been named. The Rockefeller Foundation was announced as the donor of a sum large enough to enable the opening of the new school.

Professor Hubbard is chief editor of *City Planning*, the official magazine of the profession, and a member of the firm of Olmsted Bros., landscape architects and city planners. Last year he received a grant from the Harvard Milton fund for research to enable him to make a field study of city planning and zoning progress in the United States. The results of this study have recently appeared in a volume entitled "Our Cities Today and Tomorrow."

The degree of Master in City Planning is the first of its kind to be offered by any American university. The new school is an additional unit with the schools of architecture and landscape architecture under the faculty of architecture.

Railway Bridge and Building Men Discuss Their Work

Concrete mix in relation to the economic and practical sides of good concrete production was one of the prominent subjects of discussion at the annual meeting of the American Railway Bridge and Building Association, held at New Orleans, La., Oct. 15-17.

A report on protection of underground water pipes included various methods, but it was pointed out that local conditions of soil and other factors must be considered in selecting any material or method. Many paints which are satisfactory above ground may fail to give permanent protection on buried pipes, while embedding the pipes in concrete is of prohibitive expense, especially as piping in railway service often has to be altered or shifted. In the committee's opinion, many pipe lines are placed underground from force of habit and could be placed overhead with considerable advantage. It is estimated that railway water pipe lines aggregate some 20,000 miles of wrought-iron and 11,000 miles of cast-iron pipe.

Matters relating to personnel included a report on the elimination of accidents to men working on trestles, scaffolds or other places where they are off the ground, and another on the selection and training of foremen. This last subject is a troublesome one, as the importance of the work of such men is increasing, while railway contracts or agreements with employees usually require consideration of seniority in cases of promotion. There is no general or uniform practice, but the committee suggested that supervisors and foremen should recruit their gangs from three classes of men: (1) young college men, (2) young men with only school education but willing to study, and (3) older men with practical experience. Such a gang would be well balanced and with proper training should provide men capable of being advanced to higher positions.

Individual papers included the Suisun bridge, by H. I. Benjamin, assistant bridge engineer of the Southern Pacific Railway; the burning of the floor of the Harahan bridge, by I. L. Simmons, bridge engineer of the Rock Island Lines; and the use of cypress and Southern pine in bridge work by representatives of the lumber manufacturers' associations. Officers elected for 1929-30 include: president, J. S. Huntoon, assistant bridge engineer, Michigan Central Railroad; vice-president, C. S. Heritage, Kansas City Southern Railway; A. I. Gauthier, Boston & Maine Railroad; H. I. Benjamin, Southern Pacific Railway, and W. T. Krausch, Chicago, Burlington & Quincy Railroad. C. A. Lichty, Chicago & Northwestern Railway, Chicago, was re-elected secretary.

Engineering Council Acts on Pending Legislation

Members of the administrative board of the American Engineering Council met in Washington Oct. 24 and 25 to consider more than 30 bills and resolutions pending before Congress. Approval was given to a bill providing for the planning of a waterway for ocean-going vessels from the Great Lakes to the Atlantic by way of the St. Lawrence River and the Welland Canal, with the recommendation that a representation of civilian engineers be included on the proposed board of American and Canadian engineers which will work on the project. Approval was also given in principle to a bill authorizing the employment of civilian consulting engineers for the air corps and the Ordnance Department, but the comment was added that the rates of compensation provided are insufficient. Opposition was expressed to a bill requiring contractors engaged in public works in the United States to give certain preferences in the employment of labor. The erection of a suitable monument in Washington to Major Pierre Charles L'Enfant was recommended to Congress.

Other measures approved include a resolution for the establishment of a commission to plan a National Museum of Engineering and Industry, a bill creating a safety division in the Bureau of Labor Statistics, and a similar measure providing for co-ordination of the public health activities of the government.

Reconstruction of the Potomac Canal in Washington was urged as the share of the engineering profession in the George Washington bicentennial celebration in 1932. This canal, which is about a mile long, was built by Washington to take boats around the Great Falls of the Potomac River, and it is believed to be the only relic of Washington as an engineer left in this country. The reconstruction would cost about $200,000.

Two pending bills on patents were opposed. The first of these would allow only licensed attorneys to practice before the Patent Office, excluding engineers and scientists. The second provides for compulsory licenses for unused patents. Approval was given to a bill to investigate procedure in the Patent Office and also recommendations to remedy conditions.

A recommendation of the committee on research that a group of experts be appointed by Arthur W. Berresford, president of the Council, to co-operate with the Bureau of Aeronautics and the Department of Commerce in making a study of the problems involved in the design of airports was approved. The committee will not attempt to solve any specific technical problems but will make available existing material indicating the importance of expert engineering advice in planning airports.

California Governor Appoints Registration Board

Governor Young has appointed as the commission to administer an act providing for the compulsory registration of all civil engineers in the State of California Henry J. Brunnier, consulting structural engineer, San Francisco; Donald M. Baker, consulting engineer, Los Angeles, and Albert J. Givan, Sacramento. The provisions of the act were given in *Engineering News-Record*, July 4, p. 30.

New York Governor Proposes Bridge Across St. Lawrence

Governor Roosevelt of New York has issued a statement in which he expresses his interest in the problem of better facilities of communication between the northern counties of the state and the Province of Ontario. No highway bridge now connects the United States and Canada along the St. Lawrence River, and Governor Roosevelt announces that he will "recommend to the next legislature the creation of a public bridge authority with the duty of conferring with the Ontario authorities for the purpose of locating a highway bridge at such point across the St. Lawrence River as may seem to be the most feasible and the most useful to the largest number of persons on both sides of the border and with the right to issue securities."

The Governor proposes a toll bridge to be made free when the cost has been repaid.

WASHINGTON NOTES

By Paul Wooton
Washington Correspondent

Congressional Action Expected on Floodways—Report Soon on Ship Canal Across New Jersey

EVERY effort is being made to complete the special survey of the Boeuf and Atchafalaya basins before the convening of the December session of Congress in order that consideration may be given the problems of a narrower, controlled floodway to carry floodwaters diverted from the Mississippi River. There is some question whether or not Congress will be willing to alter the plan. Friends of the Jadwin plan say that the cost difference between a fuse-plug levee and the controlled opening is $700,000,000. A large item in their calculation is for the maintenance of the narrow floodway, which is figured at $10 an acre per year. Since even the narrow floodway would contain nearly 1,000 square miles, the maintenance cost alone would be $6,000,000, it is estimated. This, capitalized at 4 per cent, would add $150,000,000 to the project. Compensation for lands and the expense of carrying railways and highways over the floodway account for the remainder of the excess claimed.

Despite the President's statement that the west bank diversion is to be reconsidered, Secretary Good is not prepared to reallocate for levee and revetment work on the main river the $2,500,000 allotted to floodway construction. He says there are ample funds available to push work on the main river to the maximum extent practicable.

Montana Power Disputed

That the Flathead Lake power project in Montana may become involved in a controversy of the Muscle Shoals type became apparent at a hearing before the Federal Power Commission. The commission's staff accepted the development plan of the Rocky Mountain Power Company and rejected that of W. H. Wheeler, the engineer who built the bridge over the upper Mississippi at Minneapolis. Mr. Wheeler protested the decision. The rules of procedure of the commission provide that in such an event a hearing shall be held by the commission's staff. Mr. Wheeler contended, however, that the case was of such importance that the hearing should be before the commission itself. After argument on this point before the executive secretary of the commission, all agreed to that departure from the usual practice.

In his statement to the commission Mr. Wheeler contended that much of the power aavilable at Flathead Lake should be used in connection with the production of high-test fertilizer. He declared that this power project is better located than is Muscle Shoals as a center of fertilizer production for all parts of the country, because of the proximity of phosphate rock and the availability of other fertilizer ingredients. He contends that he can build this project for $85 per horsepower of average output, which would make possible production of electricity at very low cost. Representatives of the Rocky Mountain Power Company had not testified at the time this was written.

New York City Piers

The application of the New York port authorities for an extension of the pierhead line 100 ft. riverward is still an open issue, according to an announcement by the Secretary of War. Secretary Good stated that he discussed the matter with New York City officials last week. No new material has been brought forth that would justify a revision of the War Department's decision to refuse the application, he said.

M.R.C. Headquarters

In discussing the controversy over the location of the headquarters of the Mississippi River Commission, Secretary Good stated that further consideration is being given the matter. Several weeks ago a delegation from the St. Louis Chamber of Commerce called at the War Department and protested against the order calling for the removal of the headquarters of the commission from St. Louis to Vicksburg. The order has not been recalled, although the Secretary has directed General Brown, Chief of Engineers, to restudy the case. The general opinion among Senators and Representatives from states in the lower Mississippi Valley is favorable to the policy of moving the offices of the commission to a site nearer the center of the flood-control operations. It is not believed that the protest raised in St. Louis will be sufficient to stay the execution of the order moving the headquarters down to Vicksburg.

Tidal Power Project Revised

In an effort to expedite the authorization of his Passamaquoddy Bay project Dexter Cooper has modified the application filed with the Federal Power Commission so as to bring the development entirely within the territorial waters of the United States. Difficulty was being experienced in securing an extension of time from the Canadian authorities. The revision is such that will permit of the expansion of the project later to include Canadian waters. The commission has referred the new plan to the Corps of Engineers for a report on the project as altered.

Ship Canal Report Expected

A report will soon be submitted to the Chief of Engineers on the proposed ship canal connecting Philadelphia with lower New York Bay. This project involves the construction of a canal across the

State of New Jersey connecting the Delaware and Raritan rivers and will be the last remaining link to be authorized in the intracoastal route between Boston and Jacksonville. The survey is being made for a canal 12 ft. deep and 90 ft. wide. No locks are called for. This will be the same size as the present Delaware and Chesapeake Canal and the waterway between Chesapeake Bay and Albemarle Sound, N. C. From Wilmington to Charleston the waterway has an 8-ft. authorized depth, while from Charleston to Jacksonville the depth provided for is 7 ft.

As an illustration of the amount of traffic that passes through the completed portions of this waterway, it is pointed out that the Chesapeake and Delaware Canal handled 608,000 tons of freight in 1927 and more than 700,000 tons in 1928. About 35,000 passengers are carried over this canal annually. The value of the freight carried each year amounts to something more than $44,000,000.

Water Commission Meets

The International Water Commission, engaged in a study of the disposition of the waters of the Rio Grande, Colorado and Tia Juana—all international streams—is in session in Washington. The full commission is in attendance.

Personal Notes

RAYMOND B. TRAVER, superintendent of highways for Onondaga County, N. Y., will retire from that position within a few weeks, and will devote his efforts to the laying out of airports for private interests. His successor will be chosen from the civil service list after an examination is held.

WILLIAM ADAMS DELANO, president of the New York Chapter of the American Institute of Architects, has been appointed by President Hoover a member of the National Capital Park and Planning Commission, succeeding the late Milton B. Medary, of Philadelphia.

M. E. BRIAN, city engineer of Windsor, Ont., for nearly 21 years, has resigned, the resignation to take effect not later than the end of the year. Mr. Brian has accepted an executive position with Cadwell's, Ltd., a contracting and building supply firm.

MILTON B. HAGER, of Shirley, Mass., who has been an engineer in the valuation department of the New York, New Haven & Hartford Railroad for the past 2½ years, has been appointed an assistant land appraiser with the Interstate Commerce Commission and assigned to duty in Chicago, Ill.

ROBERT A. MONROE, assistant chief of the division of civil engineering of the Pacific Gas & Electric Company, San Francisco, has resigned and will leave California on Nov. 1 to accept a position in the hydraulic department of the Aluminum Company of America, with headquarters in Pittsburgh, Pa. Mr. Monroe has been associated with the Pacific Gas & Electric Company for eighteen years. For the past four years he has acted as secretary-treasurer of the San Francisco Section, American Society of Civil Engineers.

GEORGE C. BLOUNT, division engineer of the Georgia highway department for the past nine years, has been promoted to chief maintenance engineer. E. C. GARTNER will succeed him as division engineer.

HARRY F. HUY, who has served the Western New York Water Company, Buffalo, N. Y., for eighteen years and has been its general manager since 1914, has severed his relations with that company. Mr. Huy was president of the American Water Works Association in 1925-26.

GEORGE DERRICK, bridge engineer of the Florida state road department, has resigned. He had been with the department for ten years.

THOMAS R. CAMP, chief designing engineer for Alexander Potter, consulting sanitary engineer, of New York, and formerly a member of the firm of Spoon, Lewis & Camp, consulting engineers, of Greensboro, N. C., has been appointed associate professor of sanitary engineering at the Massachusetts Institute of Technology to succeed Prof. R. G. Tyler, who has resigned to become dean of engineering of the University of Washington at Seattle.

WILLIAM E. WOOD, formerly president of the Virginia Electric & Power Company, Richmond, Va., a subsidiary of the Engineers Public Service Company, has been elected vice-president in charge of operations of the latter company, with headquarters in New York City. Mr. Wood has also been elected chairman of the board of directors of the Virginia Electric & Power Company. J. FRANK MCLAUGHLIN, since the first of the year district manager of the Southwestern district properties of Stone & Webster, Inc., succeeds Mr. Wood as president of the Virginia Electric & Power Company. Previous to his appointment to the district office Mr. McLaughlin was operating vice-president of the Virginia company.

E. M. SCOFIELD, engineering contractor and head of the Scofield Engineering Construction Company, has been appointed a member of the Los Angeles Board of Water and Power Commissioners and the appointment has been confirmed by the Los Angeles city council. Mr. Scofield succeeds Will E. Keller, who resigned recently.

J. S. GARLAND, superintendent of the District of Columbia water department since 1915, has applied for retirement, effective Nov. 1. Mr. Garland has been connected with the department for 38 years.

J. B. MARCELLUS, for 3½ years chief engineer for the Marland estate at Ponca City, Okla., on the construction of roads, water supply, lakes, sewers, underground utilities and polo fields, is now consulting engineer for the Federal Land Bank of Wichita, Kan., which covers the ninth district—Kansas, Oklahoma, Colorado and New Mexico.

JOHN FRANKLIN DODGE, petroleum engineer of the Standard Oil Company of California, has joined the faculty of the University of Southern California as professor of petroleum engineering. GILBERT H. DUNSTAN has been added to the faculty of the same institution as instructor in civil engineering. He was formerly instructor at Tulane University.

Obituary

EDGAR V. SEELER, architect, of Philadelphia, died on Oct. 26. Among the Philadelphia structures designed by him were the Real Estate Trust Building, the Bulletin Building, the Federal Reserve Bank Building, the Curtis and Penn Mutual Building, the First Baptist Church, the old Dental School of the University of Pennsylvania and the Flower Astronomical Observatory. He also designed the James V. Brown Memorial Library in Williamsport, Pa., and the Cannon Club in Princeton, N. J. He was 61 years old.

ROBERT BROWN, of Dallas, Tex., died on Oct. 20 at the age of 69. Mr. Brown began his career in building construction work in New York in 1885 and after moving to Texas he supervised the construction of the Southwestern Life, Athletic Club and Magnolia buildings in Dallas; the Gulf, Colorado & Santa Fe Building, Sealy Hospital and Union Belt and Terminal, in Houston, and the Littlefield Building, Austin. At the time of his death Mr. Brown was consulting engineer for the Magnolia Petroleum Company.

Society Calendar

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, Washington; annual meeting, San Antonio, Tex., Nov. 12-15.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, New York; annual convention, Biloxi, Miss., Nov. 13-16.

AMERICAN ROAD BUILDERS ASSOCIATION, Washington; annual convention, Atlantic City, N. J., Jan. 11-18.

INTERNATIONAL CITY MANAGERS ASSOCIATION, Chicago; annual convention, Fort Worth, Tex., Nov. 20-23.

NATIONAL PAVING BRICK MANUFACTURERS ASSOCIATION, Washington; annual meeting, Chicago, Ill., Dec. 4-6.

MISSOURI VALLEY SECTION, American Water Works Association, Iowa City; annual meeting, Sioux Falls, S. D., Nov. 6-8.

NORTH CAROLINA SECTION, American Water Works Association, Chapel Hill; annual meeting, High Point, N. C., Nov. 4-6.

Construction Equipment and Materials

Gypsum Products Not Lumber, Trade Commission Rules

Gypsum building materials made to be used in place of lumber are not lumber as the term is understood in the trade, according to findings of the Federal Trade Commission in the case of the Rockwood Corporation, of St. Louis. The corporation, manufacturing gypsum building materials, has been ordered to cease and desist from using the word "lumber" and/or the words "Rockwood lumber" in offering for sale in interstate commerce gypsum products or gypsum building materials unless and until the word "lumber" and/or the words "Rockwood lumber" are qualified by the use of the word "gypsum" or some other word or words equally explanatory in lettering equally as conspicuous as the word "lumber."

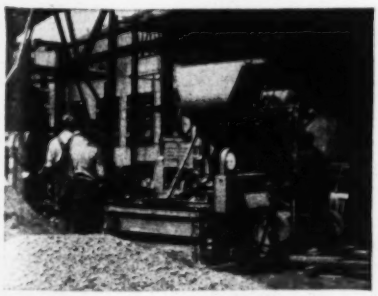
The building material manufactured by the Rockwood company has the shape of lumber and is put in place with carpenters' tools to take the place of lumber, although the appearance, weight and texture are not similar to those qualities in lumber.

New Developments

10-S Mixer Designed for Accurate Proportioning

By combining the 10-S Dandie mixer with the Weigh-Mix device used on its larger units, the Koehring Company, Milwaukee, Wis., has produced a small mixer which meets every requirement of accuracy in proportioning and speed in operation in an easily portable machine. The weighing device consists of a 2,500-lb. all-metal platform scale, a cradle to carry the scale and receive the skip, a saddle to protect the scale from being damaged should the skip be dropped, a vibrator for cleaning the skip quickly and a trailer for transportation from job to job. Cement, sand and stone are weighed separately on the three-beam scale. Water is measured by a tank. The operator controls charging as well as mixing and discharging, all operations being centralized in one control. Speed in weighing is aided by the use of double-faced indicator dial with a pointer in full view of the shovelers, inspector and operator.

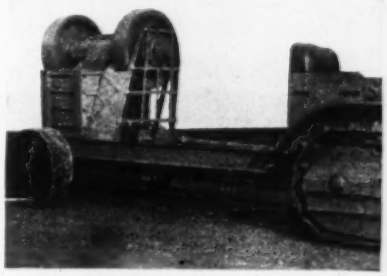
When moving the outfit from job to job, a two-wheeled rubber-tired trailer is attached to the mixer for carrying the scale and cradle.



10-S WEIGH-MIX IN OPERATION

Crusher Supplies Broken Stone for Small Jobs

Crushed rock for concrete aggregates, roadwork and other uses where the quantity desired does not justify the use of a permanent crusher can be obtained on the job by the use of the portable crusher manufactured by the Day Pulverizer Company, Inc., Knoxville, Tenn. This is designed for use with either the Caterpillar twenty or thirty tractor, and is driven through the usual power take-off. Universal couplings on the shaft make it unnecessary to disconnect the crusher unit while the machine is being moved. The crusher has a feed opening 9x16 in., and the manufacturer claims that it will produce from 6 to 10 tons of material 2½ in. and under per hour.



PORTABLE CRUSHER DRIVEN FROM POWER TAKE-OFF

Gasoline Excavator Made in ¾-Cu.Yd. Size

Supplementing the Lorain 55 and 75 excavators in 1- and 1¼-cu.yd. sizes, the Thew Shovel Company, Lorain, Ohio, has announced a new ¾-cu.yd. shovel, crane, clamshell and dragline known as the Lorain 45. Basic design and construction principles in the new model remain the same, and include the Thew center-drive design. Power is obtained from a Waukesha type H.S. motor with 5½-in. bore and 6½-in. stroke, developing 71 hp. at 1,000 revolutions per minute. The superstructure is mounted on a two-speed crawler driven by a vertical travel shaft and a horizontal propelling shaft. All gears and clutches run in a constant oil bath in a heavy steel crankcase placed high enough to afford ample ground clearance. An innovation is the mounting of steering clutches on splined shaft sections.

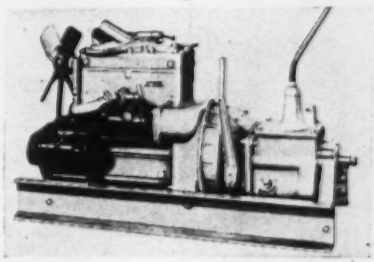
The shovel boom is an all-steel full box section. An all-steel welded rectangular section is used for the dipper stick. A small lever mounted near the operator, when actuated, pulls trip rope by means of a clutch device on the end of the swing shaft.

¾-CU.YD. CLAMSHELL EXCAVATOR

Crane, clamshell and dragline booms are all-steel latticed construction built in two sections with interchangeable boom heads. The standard length is 35 ft., but other lengths can be furnished.

Industrial Motors Equipped With Variable-Speed Transmission

Unusual items of equipment furnished with the new four-cylinder model "BC" Fuller & Johnson industrial power unit of 6-10 hp. include a variable-speed transmission with three forward and reverse speeds; an inclosed dry disk type clutch; and an electrical equipment for self-starter and lights. The power unit is intended for use in industrial trucks, small excavating machines, conveyors, small tractors and similar installations. The transmission is designed to permit continuous operation in first or second gear without undue strain or wear. When such use is not intended, a smaller transmission is furnished. The clutch is mounted on the main shaft and operates at engine speed; it can be operated with either a hand or a foot lever. Electrical equipment includes starting motor, generator and six-volt battery.

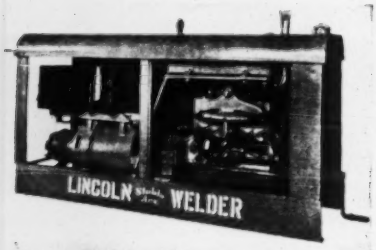


6 TO 10-HP. MOTOR

Similar equipment is available on other motors made by the Fuller & Johnson Manufacturing Company, including the two-cylinder 3 to 5-hp. and the four-cylinder 20 to 25-hp. power unit. The company's address is Madison, Wis.

Gasoline Welder Equipped With Fuel-Saving Device

In the new gas engine-driven 200-amp. welder recently introduced by the Lincoln Electric Company, Cleveland, Ohio, an automatic idling device is incorporated which automatically reduces

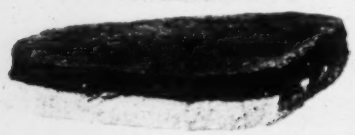


200-AMP. WELDER

the speed of the engine when welding operations cease and accelerates it to proper speed as soon as welding is resumed. The entire outfit is inclosed by a welded steel canopy as a protection from the weather. Operating controls are contained in a ventilated steel cabinet. A four-cylinder Waukesha motor operating at 1,500 revolutions per minute supplies the power for the unit.

Asphaltic Compound Has Many Uses

Asphalt is the base of a compound known as Unicrete manufactured by the Union Products Company of Cleveland, Ohio, for use in resurfacing or patching old floors, the construction of new floors, as a roofing material and as a protective coating for exterior or interior surfaces. When mixed with cement, sand, gravel and water to a mortar-like consistency, Unicrete forms a resilient concrete which hardens in approximately 36 hours. This, according to the manufacturer, can be laid over any kind of rough, worn or



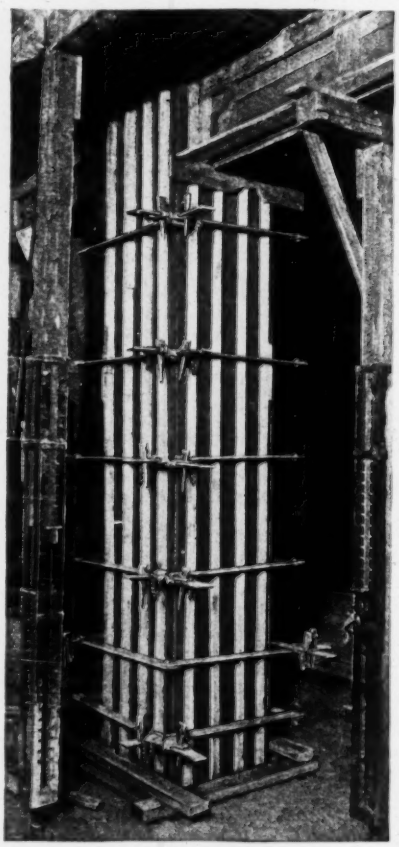
RESILIENT FLOORING ON CONCRETE BASE

broken floor or over a new concrete base to provide a smooth, solid, dustproof, acid-proof and waterproof wearing surface which will carry 5-ton loads on steel wheels. The proportions of the ingredients are changed to meet various conditions. For floor surface, the recommended depth of the compound is ¼ in., at which the weight is less than 5 lb. per square foot. The thickness may be tapered down to a feather edge to avoid the necessity of raising doorways and to cover floor irregularities.

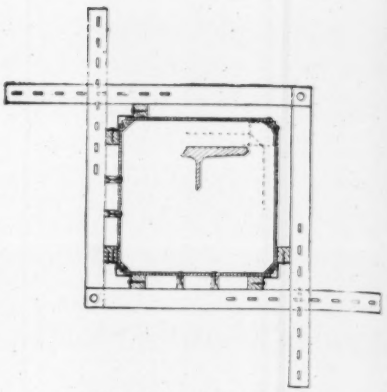
A second form of the material, known as Unicrete Bond, is used to secure perfect adhesion to the old surface, and is also applicable to roofs and as a protective paint for concrete, steel or wood. It consists of pure water-suspended asphalt without oil, pigment, fillers or solvents.

Forms for Concrete Columns Quickly Erected

A new standardized form for concrete columns has been developed by the Dowd Concrete Form System, Inc., Chicago, Ill. This, it is claimed, has but half the weight of the ordinary board form, can be made, erected and dismantled in much less time, and has a smooth, hard surface which prevents the formation of board marks. It is adaptable to both steel skeleton and reinforced-concrete column construction, and can also be used for foundation piers and for fireproofing wood columns. In erection, lightweight siding is nailed to vertical wood chamfer corners and to vertical battens. The assembly is held together by the usual type of column clamp, but the stiffness of the form permits the use of fewer of these than usual. For steel skeleton construction, internal steel spreader bands are used to hold the form in place. To remove the form, the clamps are taken off, and the siding, being held in place only by lathing nails, is easily removed and made ready for re-use. When the size of the form is to



FORM IN PLACE READY FOR POURING CONCRETE



SECTION OF COLUMN FORM

be reduced, there are no clinched nails to be removed. Two sides of the form are placed back to back and cut to the desired size.

Business Notes

THE FEDERAL TRADE COMMISSION has taken action on rules of business practice adopted by the lime industry at a conference held in Washington last June. Eleven rules were affirmatively approved, covering unfair methods of competition, and seven more were accepted as expressions of the trade.

HERCULES POWDER COMPANY, Wilmington, Del., announces that J. J. Kelleher has become associated with the contractor's division of its explosives department, with headquarters in Wilmington. J. R. St. Clair, formerly of the sales force of the company in Duluth, Minn., is now attached to the explosives technical service staff in Wilmington.

CHAIN BELT COMPANY, Milwaukee, Wis., has opened a New England district office in Boston, Mass., under the supervision of J. K. Merwin.

ALEXANDER MILBURN COMPANY, Baltimore, Md., has opened an office in Los Angeles, Calif., under the supervision of George R. Roberts, formerly with the Purox Company.

Costs and Contracts

E. N.-R. Index Numbers

Cost		Volume	
Oct. 1, 1929	**206.32**	**Sept., 1929**	**340**
Sept. 1, 1929	207.57	August, 1929	290
Oct. 1, 1928	207.71	September, 1928	296
Average, 1928	206.78	Average, 1928	287
Average, 1927	206.24	Average, 1927	263
1913	100.00	1913	100

This Week's Contracts

Heavy construction contracts, reported by *Engineering News-Record* in the week of Oct. 31, with some comparisons, total as follows:

(In Thousands of Dollars)

	Oct. 31, 1929	Oct. 24, 1929	Oct. 25, 1928
Buildings:			
Industrial	$59,222	$7,886	$10,318
Commercial	19,553	30,694	59,576
Streets and roads	6,342	7,064	10,720
Other eng. constr.	10,576	10,318	9,768
Total	$95,693	$55,962	$90,382
Total, all classes, Jan. 1 to Oct. 31:			
1929			$3,550,214
1928			3,035,459